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Marketing New England Poultry

2. Economies of Scale in Chicken Processing

By

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in cooperation with

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Preface and Acknowledgements

This bulletin is the second in a new series to be issued by Agricultural Experiment Stations in the New England States and involves, in most instances, direct cooperation with the Agricultural Marketing Service, U.S.D.A. The series will deal with various aspects of poultry marketing in New England. This publication analyzes the potential economies of scale in chicken processing in plants performing straight-line evisceration under Federal Inspection and the nature and magnitude of changes in non-inspected New York Dressed plants required to achieve this status.

The authors appreciate the cooperation of the processing plant operators who furnished data on costs and input-output relationships and of those manufacturers of equipment and supplies for poultry processing plants who furnished data on specifications, capacities, and costs. They wish especially to acknowledge the assistance and critical appraisal received from W. F. Henry, of the Agricultural Economics Department of the University of New Hampshire; A. A. Brown, of the University of Massachusetts; and from Norris T. Pritchard, Market Organization and Costs Branch, Marketing Research Division, Agricultural Marketing Service, U. S. Department of Agriculture. In the development of the model plants, helpful suggestions were made and data were provided by the Poultry Division, Agricultural Marketing Service, U. S. Department of Agriculture, and by the Department of Agricultural Engineering, University of New Hampshire. Dister L. Deoss rendered material assistance in the collection of data and John Payne aided in its analysis.

Summary

In recent years, evisceration of poultry in country plants in New England has been increasing. Additional plants are converting from selling New York Dressed birds to selling the eviscerated product.

Previous work has suggested the existence of substantial economies of scale in dressing. This study determines the nature of scale effects on costs in plants preparing an eviscerated product.

Economies of scale are much more pronounced for plants processing broilers than for those processing fowl. Under standard conditions, and with each of 10 sizes of model units operated at 100 percent of capacity, unit costs in processing broilers decline from 5.1 cents per pound (live weight basis) at 150 birds per hour to 2.6 cents per pound at 10,000 birds per hour. About 75 percent of the decrease occurs between the smallest (150) unit and the 2,400 size.

In contrast, unit costs in processing fowl decline from 4.0 cents per pound at 120 birds per hour to 2.6 cents per pound at 6,000 birds per hour. About 85 percent of the decrease occurs between the smallest (120) model and the 480 size. Because of the aggregate volume of fowl available and its seasonal and area distribution, it would be impractical for large plants to have fowl as the major product.

Small plants can enhance their competitive position by utilizing fowl and other heavy market classes, whereas larger plants usually should concentrate on broilers. Smaller plants may also prove economical in some non-commercial poultry areas, or in situations where the operating margin of the firm can be widened by advantageous buying and selling prices and practices.

In the short-run, use of depreciated and low-cost resources and substandard practices may offset some of the inherent economies of scale. But over a longer period, economic pressures will force a continued reduction in the number of smaller plants and more attention by all plants to the effects of size on costs. Nevertheless, adjustments which individual units make will be affected by institutional and area considerations, including costs of assembling and distributing and the degree of integration involved.

The present processing system for New England contains substantial inefficiencies. These relate both to the practices of individual firms and to structural features.

About 240 slaughtering and eviscerating plants, and a number of additional establishments eviscerating prior to the retail level, processed 427 million pounds of poultry in 1957 at an estimated cost of $17.7 million. If all evisceration were done in slaughtering plants and if these plants operated at levels of efficiency comparable to the model units described in this bulletin, processing costs could be reduced to $16.1 million.

However, one-fourth as many units, but of larger average size and with capacity operation at model levels of efficiency, could have processed the same volume for $14.1 million. In future years, economic forces will cause reductions in unit numbers and increases in unit size. If output were ex-

panded 40 percent, one-fourth as many units as exist today could process the larger volume with only a 10 percent increase in total dollar costs above 1957 actual levels.

Processing plant costs can be separated into four groups: variable operating; constant-unit operating; fixed operating; and fixed overhead. For any given size of plant, unit costs decline in direct relation to increasing volume for the fixed operating and fixed overhead groups. Unit costs in the variable operating group, of which plant labor is the main component, decline at a decreasing rate as volume increases to 100 percent of capacity. Beyond full capacity, unit costs of this type increase.

Prices of many items used in processing are determined by forces external to the poultry industry. Rates of use of supplies, materials, utilities, and miscellaneous items are related to trade practices, sanitary standards, and machine capacities. Hence, the main areas in which plant management can make decisions relate to the substitution of capital for labor, organization of the working force, and capital rationing.

Plants which were built in earlier years for New York Dressing generally included substantial holding areas. Utilization of most of such space and alterations at nominal unit costs will enable such plants to convert to production of an eviscerated product at the same or higher plant capacities. Additional expenditures for equipment should not materially increase unit costs in converted plants.

Conversion to Federal Inspection should not result in any material change in the unit cost of investment in buildings. Increases required in the number of employees are small. In terms of model plants, output per worker might decrease and costs increase. However, in terms of actual plants and the present system, improved efficiency will probably obscure any such effect.

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Marketing New England Poultry

2. Economies of Scale in Chicken Processing

by

George B. Rogers and Edwin T. Bardwell*

I. Objectives and Methods of Study

The developments of new technology in poultry processing, a widening mass-market demand for chicken, and structural changes in the industry have focused increased attention on the enhancement of efficiency through increased volume. This report analyzes the economies of scale inherent in chicken processing, and the effects which such conditions could have on the efficiency of the New England industry and individual firms within it.

Expansion of plant capacity is likely to be considered by management in many processing plants. Hence, the inclusion of plants with a wide range in capacity (150 to 10,000 broilers per hour) will provide a measurement of the effects of expansion. In 1956 when this study began, the largest New England plants approximated 5,000 broilers per hour in capacity. By early 1958, some plants were approaching 7,500 per hour. The minimal level (150 broilers per hour) separates plants oriented toward supplying wholesale and jobbing outlets from those engaging in direct-to-consumer and retailer selling.

Economies of scale in New York Dressing broilers and fowl were suggested by an earlier analysis of selected major cost items. However, it was anticipated that inclusion of all cost items and addition of the eviscerating operation might affect the position of processing units of various sizes.[1] Thus, this report examines the question of economies of scale in plants producing eviscerated broilers and fowl.

Utilization of excess holding space in the feeding station is of major importance in the transition of plants from dressing to straight-line eviscerating. In the analysis of plants producing New York Dressed poultry, holding capacity was provided for a full day's volume. Most plants operating

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[1] Rogers, G. B., W. F. Henry, A. A. Brown, E. T. Bardwell, and D. L. Deoss, *Economies of Scale and Current Costs in New York Dressing Broilers and Fowl*, University of New Hampshire, Agricultural Experiment Station, Agricultural Economics Research Mimeo No. 20. March 1958, p. 8, 15-16.

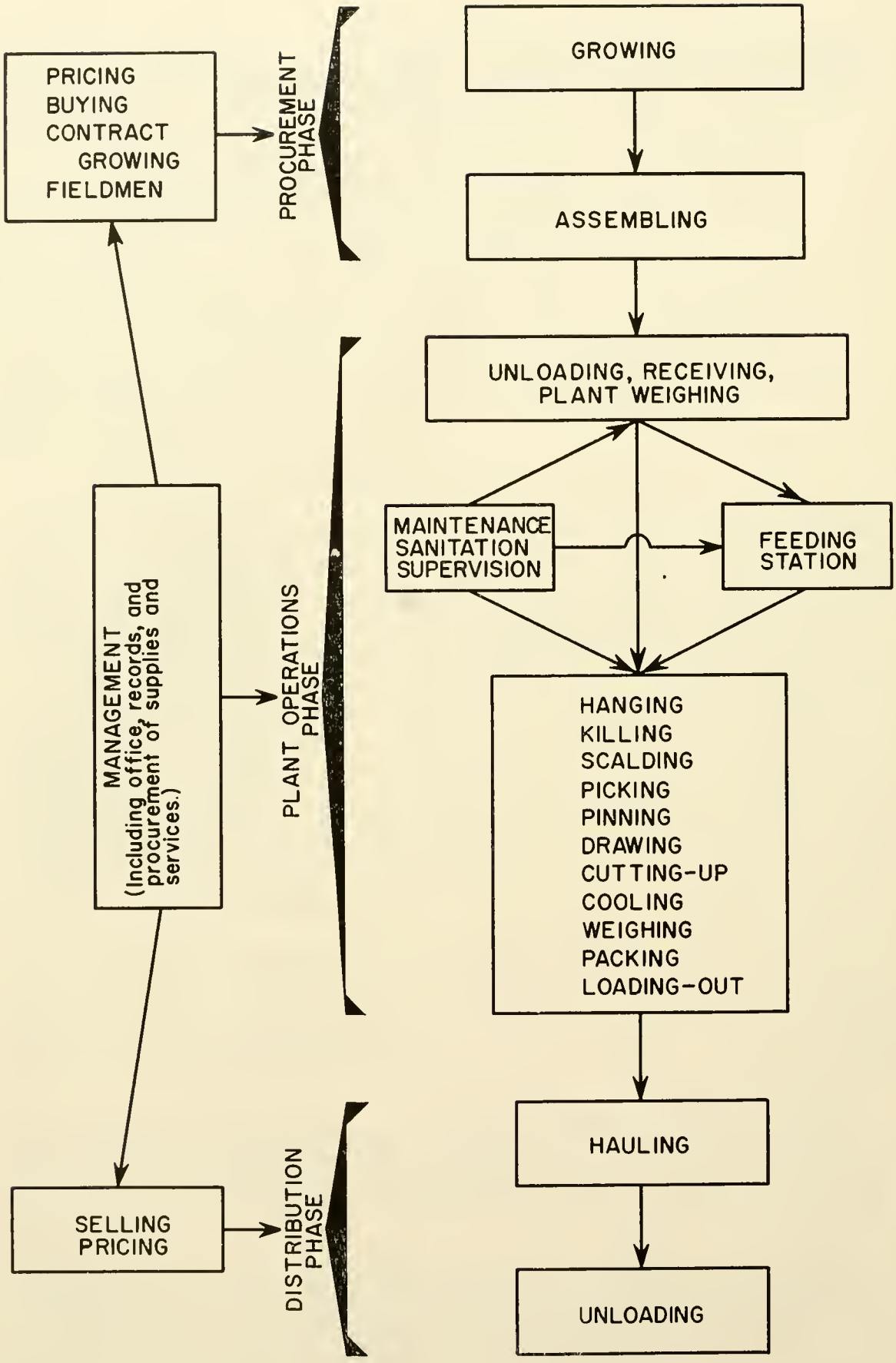

Figure 1. Functions Carried Out by Poultry Processing Firms.

today have such an area, but it is not being fully utilized. The present practice is to slaughter out-of-crates, insofar as possible. Hence, holding capacity in the feeding station of plants developed in this report provides space only for an occasional truckload of birds.

The enactment of the Poultry Products Inspection Act makes desirable the construction of model plants which would comply with the provisions of this Act and regulations issued pursuant to it. This is accomplished for all sizes of plants projected, inasmuch as even plants not selling in interstate commerce may face more stringent State or local regulations in the future.

This study deals with plant operations only, covering the fixed and variable cost items involved from the receiving of live birds to the loading out of processed birds, inclusive. Since optimum adjustments cannot be predicted on the processing segment alone, later reports will treat assembling, distributing, and integration of production and marketing functions. These subjects are likely to have considerable bearing upon the eventual choice of processing facilities in particular types of producing areas and marketing situations. The functional items assigned to the procurement, plant operations and distribution phases of poultry processing units are diagramed in Figure 1.

Detailed data on plant facilities and layout, equipment, labor force, physical inputs and outputs, and accounting costs were obtained from 15 processing plants in New England. These plants were among the most efficient in their size groups, and approximately corresponded in capacity to some of the synthetic model sizes selected. General information, previously obtained from a survey of a larger number of units, and descriptive material, plans and data from discussions with representatives of firms selling equipment and supplies to the poultry processors were also used.

Study of economies of scale is usually accomplished by synthesis of model plants of different capacities and by standardization of their operations. The 10 model plants constructed for subsequent analyses were standardized insofar as available technology and least-cost methods permit. Such standardization relates to facilities, equipment and practices. Both the resource and input-output levels were synthesized on the basis of known attainable levels of requirements and efficiency. Basic projections were made for the 100 percent of capacity level for each model size. Input-output data from actual plant records formed the basis for extending certain unit costs to lower and higher levels of output. Cost rates were those generally applicable during 1957-58.

In an earlier study, the percentage utilization of plant capacity was observed to increase with plant size. This situation may relate to the magnitude of plant and equipment costs, to emphasis on distribution in lieu of processing, and to the supply situation.[2] In the current analysis, concern is with the processing plant alone. Flexibility of supply and capacity of outlets is assumed. Projection of levels of operation ranging from 30 to 130 percent of capacity for each size were used to develop individual plant cost curves.

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[2] Rogers, G. B., W. F. Henry, A. A. Brown, E. T. Bardwell. *Marketing New England Poultry, 1, Characteristics of the Processing Industry*, Univ. of N. H., Agric. Exp. Sta. Bul. 444. Sept. 1957, p. 23-24.

Model units were rated according to the number of 3.5 pound broilers (live weight) and 6.0 pound fowl processed per hour of operation. These were selected as most representative of the market classes handled by New England plants.

Most plants producing eviscerated poultry find the cutting up of a portion of their output both a convenience and a necessity. Hence, the models provide for this function to the extent of 20 percent of aggregate volume.

Wage scales and labor conditions used in this study approximate those found in modern plants. For operations at 100 percent of capacity, a 5-day, 40-hour operating week and 247 working days per year were assumed. This allows for holidays and paid vacations for employees averaging 14 additional days per worker per year.

Wage rates for plant workers were established at $1.35 per hour for men and $1.20 per hour for women, plus 5 percent fringe benefits. The ratio of women to men was about 9:5. Thus, the average wage cost per hour, including fringe benefits, was $1.30 per hour. Time-and-a-half was assumed beyond 40 hours per week.

Single shift operations were assumed for all model plants. Further economies could be achieved by the introduction of a second and possibly a third shift provided certain related problems could be resolved. Even though the same physical plant set-up could be employed, more labor and equipment would be required for assembling and distributing and for duplicate sets of in-plant operating and supervisory personnel. Despite more rapid depreciation of equipment and increases in repairs and maintenance, a net decrease in average unit cost would probably result. Some plant operators indicate that the principal deterrents to multiple-shift operations are the difficulties in duplicating an experienced supervisory group and additional operating crews of equal capability during the less desirable (from the employee's standpoint) evening and night shifts. However, this may be more important as a short-run rather than a long-run consideration.

The level of technology employed in model plants approximates that in operating New England plants. In the future, additional efficiencies in plant operations may be achieved with new technology involving more extensive mechanization. Some is already in planning or production by equipment-manufacturing firms. The principal areas which seem to warrant increased attention are receiving, cooling, packing,[3] cutting-up and freezing. Attention to these operations may enable further economies to be realized at each successive size level and even well beyond the 10,000 broilers per hour projection. This could occur even though current technology employed in the dressing and eviscerating operations alone may not indicate such to be probable.

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[3] The following publication, released after this study had been completed, should be valuable to plant operators: Childs, R. E., and P. D. Rodgers: *Methods and Equipment for Ice-Packing Poultry*. Mktng. Res. Div., Agr'l. Mktng. Service, U.S.D.A., in cooperation with University of Georgia, College of Agriculture Experiment Station. Mktng. Res. Rpt. No. 242. Dec. 1958.

II. Classification of Processing Plant Costs and Their Behavior in Relation to Volume

Considerable variation exists in the manner and detail in which poultry processing plants keep records. Hence, to compare plant records and reduce them to usable guideposts for studying economies of scale, it was necessary to establish a limited number of cost groupings and a theoretical framework.

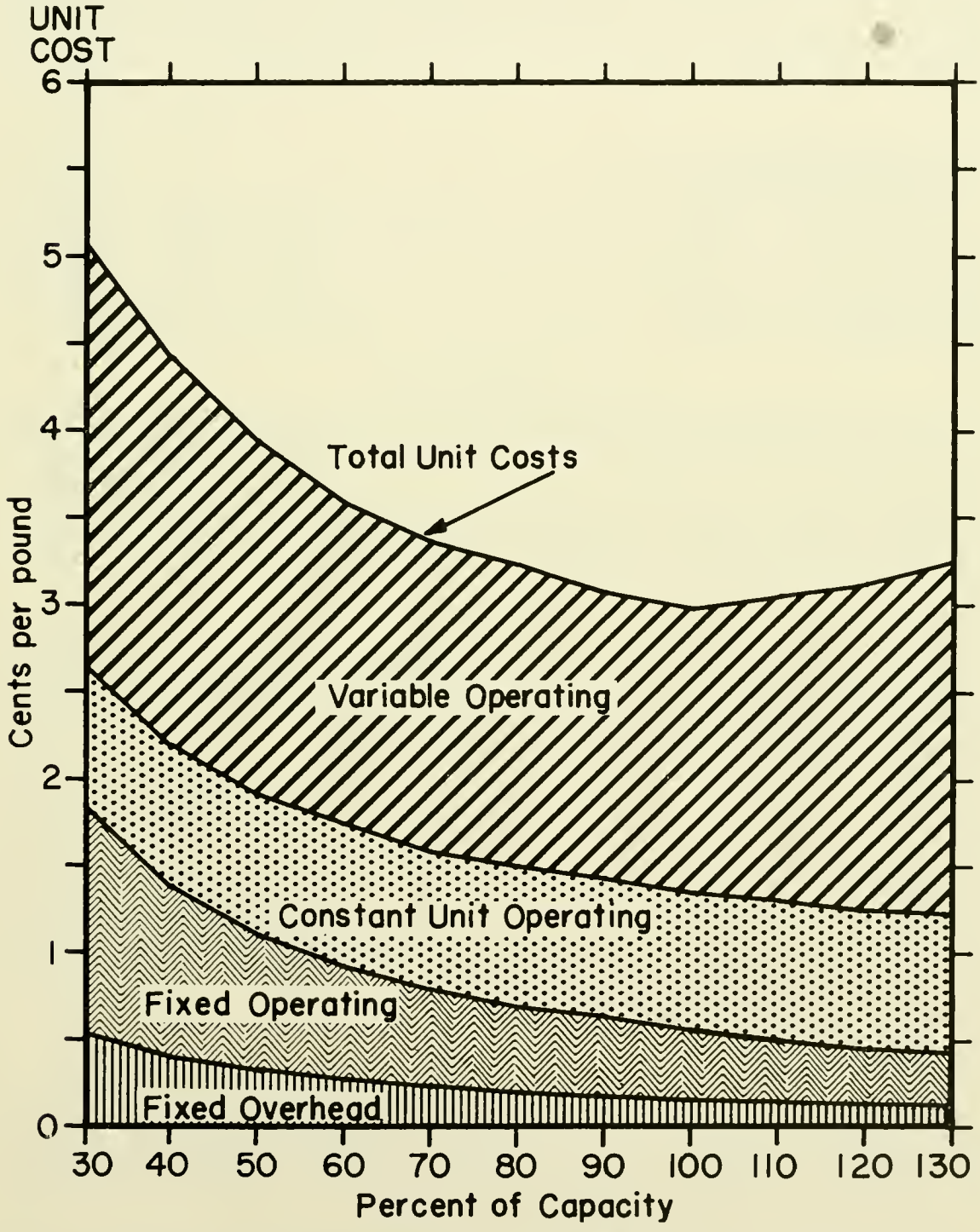

Figure 2. Behavior of Cost Groups in Model Plant Capable of Processing 3600 Broilers Per Hour.

Unit costs were determined only in relation to volume. This obscures other types of variations due to season and market conditions. Costs which vary seasonally are: heating, ice, and labor. Market conditions affect short-run buying and selling costs.

Costs were classified under four types: variable operating, constant-unit operating, fixed operating, and fixed overhead. The allocations made are mutually exclusive with respect to all major items. *All unit costs in this report are on the basis of live weight.* They can be converted to an eviscerated weight basis by dividing by the percentage yield from live to eviscerated weight.[4] To convert these costs to an operating margin some allowance also should be made for net profit and for the cost of short-term (operating) loans. Figure 2 illustrates the behavior of major cost groups for one plant size.

Variable Operating Costs

These items comprise the only cost element which increases on a unit basis after 100 percent of capacity is reached. This produces an upturn in the total unit cost curve for each plant in this study. Major components are wages (including fringe benefits), utilities, variable repairs, and wear depreciation.

Wages

Payroll and volume data indicate that output per dollar of input increases and cost per unit of output declines until 100 percent of capacity is reached. When plants are operated at more than 100 percent of daily capacity, reduced production and/or overtime wage rates decrease output per dollar of input and increase unit costs.

Utilities

Unit expense for electricity and water generally declines as plant volume increases. Rate structures usually have a fixed initial charge and successively lower rates with increases in physical units used.

Variable Repairs

In a California study, Sammet divides repairs expense into a fixed cost component and a direct repair expense determined on the basis of a percentage of replacement cost per 100 hours of usage[5]. In this study, plant repairs and maintenance, plus equipment maintenance, are treated as fixed cost components; repairs to equipment as a variable operating cost component. Figure 3 illustrates this method.

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[4] 72% can be assumed as a typical yield for converting live broilers to an eviscerated product. If it costs 5.130 cents per pound live weight to process broilers in a plant of 150 broilers-per-hour capacity (Table 2,) the equivalent cost per pound eviscerated weight would be 7.13 cents. In contrast, a plant processing 10,000 broilers-per-hour at a cost of 2.64 cents per pound live weight (Table 2), the equivalent cost per pound eviscerated weight would be 3.67 cents.

[5] Sammet, L. L.: *In-Plant Transportation Costs as Related to Materials Handling Methods — Apple and Pear Packing*, Calif. Agric. Expt. Sta. (Giannini Foundation), Mimeo Rpt. No. 142, Jan. 1953, p. 7-10.

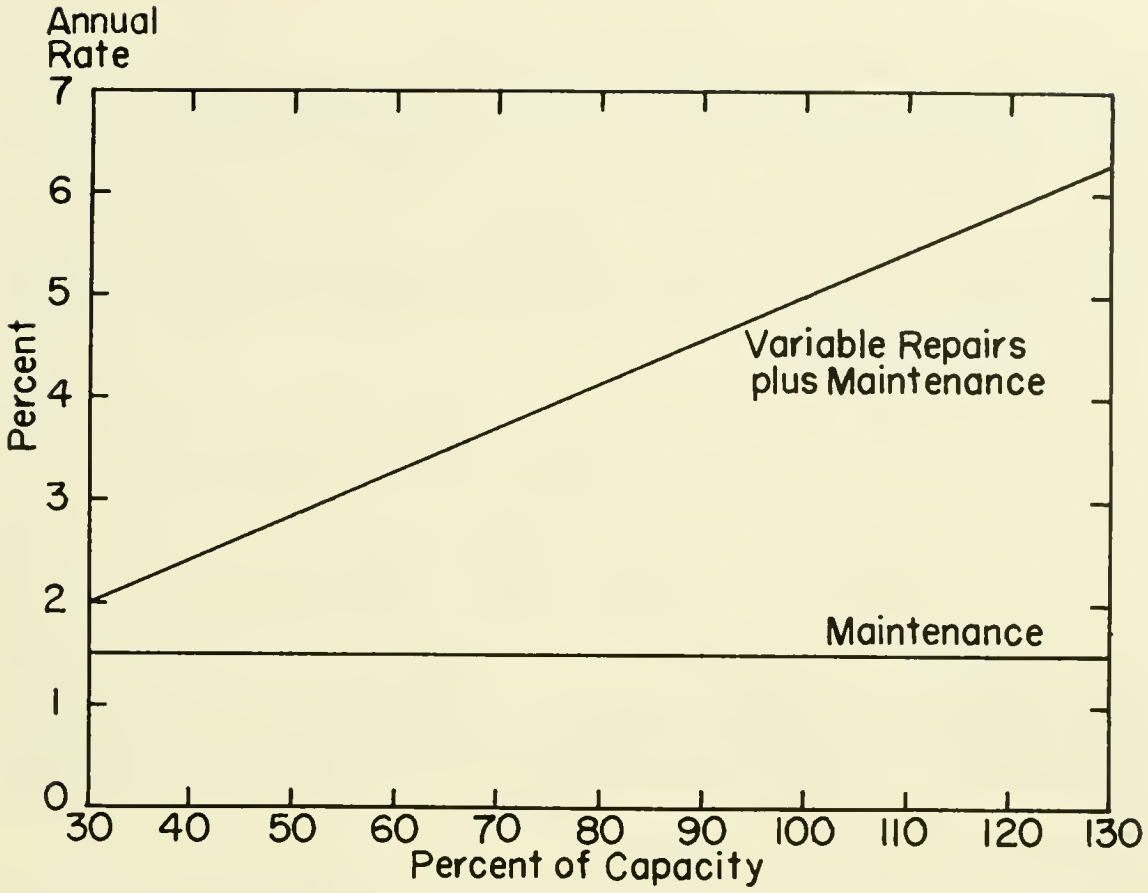

Figure 3. The Method Used for Establishing Charges for Repairs and Maintenance on Poultry Processing Plant Equipment.

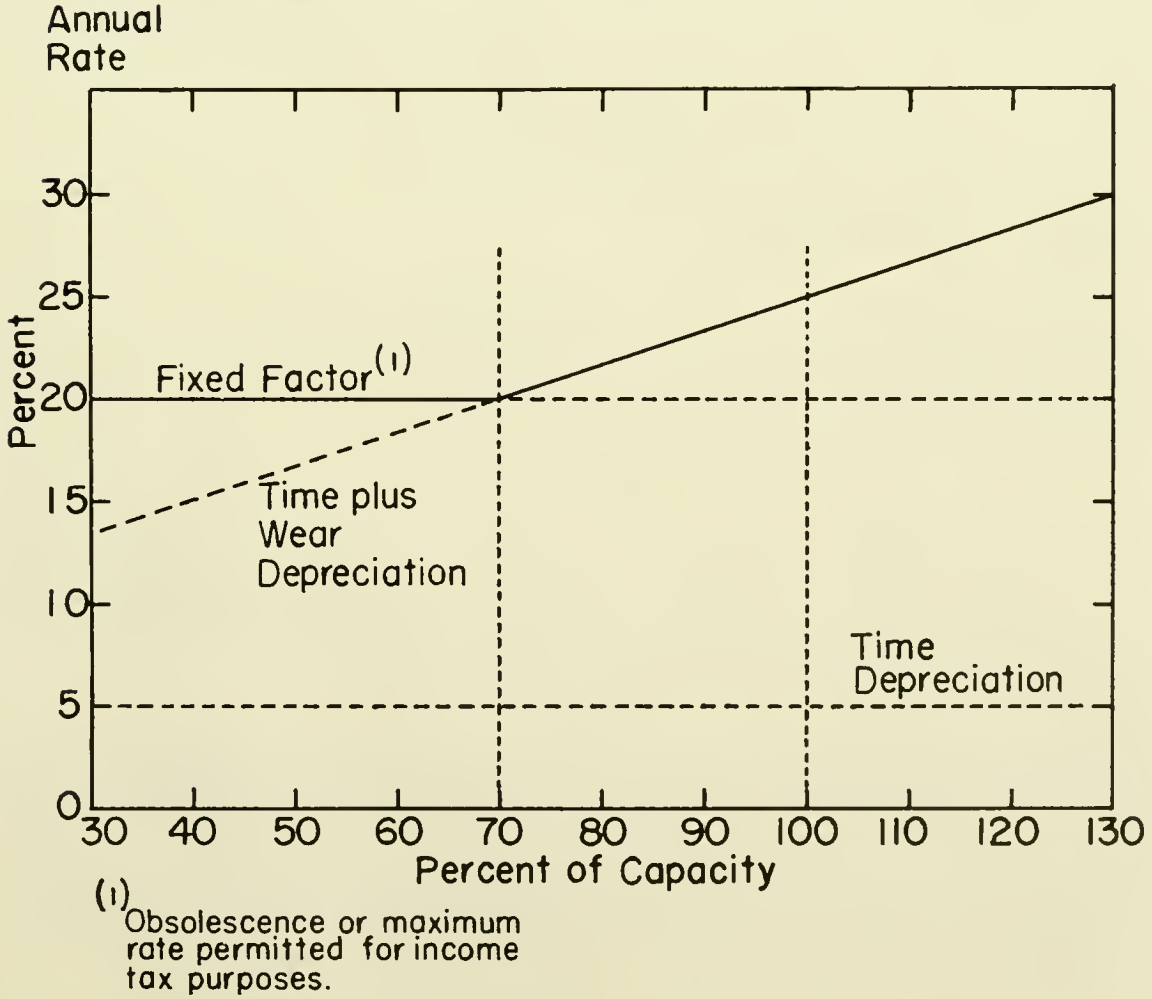

Figure 4. The Method Used for Establishing Depreciation Charges on Poultry Processing Plant Equipment.

Wear Depreciation

Scoville distinguishes between the fixed and variable elements of depreciation of equipment. "Wear depreciation" is associated with the extent of use. "Time depreciation" is defined as that arising, even when equipment is not in use, from rust, decay, or obsolescence.[6] Sammet subscribed to the division into "wear" and "time" depreciation but regards obsolescence as an unpredictable factor, accounting for which must be heavily weighted by prudence."[7]

In the poultry processing industry, technology has been changing rapidly since World War II. Plant operators anticipate further changes in the near future, both in technology and in the size and structure of individual firms. Hence, in many instances, equipment may be depreciated at a rapid rate for reasons of technological and structural obsolescence rather than from time or wear depreciation.

Some larger plants, which operate at close to 90 percent of capacity, depreciate equipment in four years, or at 25 percent a year. No firm in the study used less than a 20 percent rate. There is widespread variation with plant size in the percentage of capacity at which plants are operated, but it appears that obsolescence is considered by all operators in deciding the depreciation rate. True, the maximum rate permitted by the Internal Revenue Service is involved, but eventually this rate must bear close relationship to industry conditions.

Figure 4 shows the method used in establishing depreciation charges on poultry processing plant equipment. The time depreciation rate is set at 5 percent for all levels of operation since the equipment is well protected from the elements and damage over time can be minimized. A fixed factor (mainly obsolescence) of 20 percent governs the aggregate rate up to 70 percent of capacity. From that level on, the effects of wear depreciation govern the magnitude of the increasing charges.

Constant-unit Operating Costs

These items are, for any given size of plant, used in direct proportion to volume. Major items included are packages, ice, feed and expendable supplies. Quantity discounts which exist in the purchasing of these items determine the unit-cost associated with plant size.

Packages

This item includes wire-bound boxes, liners and marking. For purposes of standardization, it is assumed all outgoing poultry is packed wholesale-style in wire-bound boxes. In practice, some plants prepare consumer packs and smaller plants may use second-hand boxes or crates.

Ice

Present technology prescribes the use of ice for cooling and packing. While the rate of use is held constant in this report, the form of ice and the re-

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[6] Scoville, O. J.: *Fixed and Variable Elements in Calculation of Machine Depreciation*, Agric. Econ. Res., U.S.D.A., Vol. 1, No. 3, July 1949, p. 69-77.

[7] Sammet, L. L., Letter and notes to W. F. Henry, May 27, 1953.

lated equipment vary. The least-cost methods were determined in a previous analysis and for plants of 1.200 broilers per hour and up, a slush ice system is used. For smaller plants, flake ice is used.[8]

Feed

Feed cost is included at a constant rate per bird for the fraction of volume which may be held overnight. Most plants no longer make a general practice of holding birds on feed for weight gain or to recover in-transit shrinkage.

Expendable Supplies and Services

This category includes many items incidental to processing. Examples are laundry, aprons, cleansers, brooms, brushes, knives, office supplies.

Fixed Operating Costs

When a plant begins operation it sustains costs for management and certain other items essentially fixed in total. For the fixed operating cost category, unit costs decline in direct proportion to any increase in volume.

Management Salaries

These include fixed salaries of individuals such as top-level management, buyers, sellers, office managers, plant managers and superintendents, and department foremen.

Miscellaneous

This category includes such items as contributions, dues, advertising, listings, meeting expense, management travel, entertainment, legal accounting and auditing services.

Utilities

Heat and telephone are considered as part of the fixed operating cost grouping. Although a seasonal item, heat is assigned as an average monthly charge inasmuch as the inquiry is directed primarily at the effects of volume on costs. Telephone costs do not appear to vary with volume on an aggregate basis.

Fixed Overhead Costs

These costs relate to the ownership of plant and equipment. They are considered as fixed in total, over the planning period involved. Unit costs decline in direct proportion to an increase in volume. The group includes certain elements of depreciation and obsolescence on equipment, all depreciation on buildings and facilities, property taxes, interest, insurance, plant repairs and maintenance, and equipment maintenance. These items are computed as a flat percentage of value or cost.

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[8] Univ. of N. H., Agric. Exp. Sta., Agric. Econ. Res. Mimeo No. 20, op.cit., p. 9 and 11.

Depreciation, Repairs and Maintenance [9]

Rates established for both the variable and fixed components are shown in Table 1. Special rates were established on certain ice-making and handling equipment, since it required less attention and is less subject to obsolescence than line equipment.

Taxes, Interest, Insurance

Rates established are shown in Table 1. In practice, tax and insurance rates differ materially from area to area. Here they are standardized at modal levels.

Table 1. Rates Used to Determine Fixed and Variable Components of Capital Costs

Item	Building[1]	Equipment: Ice-making and Handling	Equipment: Other In-plant
Fixed Components	(percent of new cost)		
All depreciation	5	10	
Time depreciation			5.0
Taxes	1[3]	1	1.0
Interest[2]	3	3	3.0
Insurance	1	1	1.0
Repairs and maintenance	3	4[4]	1.5[5]

Variable Components, in-plant equipment Percent of Capacity	Added Increment: Obsolescence or Wear Depreciation	Variable Repairs
	(percent of new cost)	
30	15	0.5
40	15	0.9
50	15	1.4
60	15	1.8
70	15	2.3
80	16.7	2.7
90	18.3	3.1
100	20	3.5
110	21.7	3.9
120	23.3	4.3
130	25	4.7

[1] Including artesian well, office equipment, refrigerator and equipment.
[2] On new value, or 6% on average value.
[3] Total value to which applied also includes land.
[4] 1% on ice crushers.
[5] Maintenance only.

[9] See discussion under "variable operating costs."

III. Economies of Scale in Straight-Line Eviscerating Plants

Economies of scale exist in processing broilers and fowl. Average costs per pound generally decline with successively larger plants, each operated at 100 percent of capacity. But economies are greater with broilers than with fowl over the ranges of plant sizes studied.

Differences in costs between plants of various sizes operated at 100 per cent of capacity furnish a measure of the competitive position of each plant under standardized conditions. Yield is one of the conditions not covered in this study, but it is assumed, as are costs, to be standardized. Adjustments which actual plants with costs significantly above the low-cost unit must make to maintain competitive position, may be modified by individual situations. These may relate to location, plant operations or external functions. Such situations may involve: higher efficiency in some other phase of the firm's business; departures from standardized practices or factor prices; or, use of depreciated and low-cost resources.

Since the number of pounds of broilers or fowl which can be processed by each model plant size are similar, larger plants can obtain greater cost advantages in processing broilers rather than heavier birds. Conversely, small plants are in their best competitive position when processing heavier birds — even though large plants are still more efficient. The supply of fowl and the demand in relation to that for young chickens affect their prospects of achieving and sustaining this position.

Fowl is a by-product of the farm egg enterprise. Supplies are highly seasonal. Hence, the prospects of obtaining a steady supply for processing decline with increasing plant size and lower density of egg-producing flocks. On the other hand, broilers (and other meat chickens) are adapted to year-round production. A supply can be created readily through contract growing programs. Thus, while the larger plant could use fowl (or classes of poultry other than chickens) to help stabilize volume in the absence of adequate supplies of broilers, expansion or assurance of a more adequate broiler supply would probably be to such a plant's advantage. Small plants, with better prospects for obtaining a high percentage of volume as fowl, might look to other market classes as a supplement.

Broilers

For 10 model plants designed to process 150 to 10,000 broilers per hour, the cost savings from the smallest to the largest plant is 2.5 cents per pound. More than half of this advantage is obtained from 150 to 600 broilers per hour. More than three-fourths is reached at the 2,400 size. From the 2,400 to 10,000 sizes savings aggregate about one-half cent per pound. (Table 2).

Although the decline in average unit cost between successively larger plants may appear relatively small, total savings would be large. This is important in examining the implications of small differences in unit costs to individual firms and to the marketing system.[10] For example, process-

[10] Visual examination of charts showing average cost curves for various plant sizes and an interpolated economies of scale curve may mislead the casual reader. On Figure 5, the scales for the insert showing the 150 and 300 bird sizes might suggest the prospect of nominal economies beyond these volumes were the study not extended to the wider range of sizes. Hence, the existence of economies of scale should be analyzed by using tabular data on unit costs and computed dollar costs and savings.

Table 2. Broilers: Per Pound Costs of Processing in Model Plants of Selected Capacities[1]

Item	Plant Capacity — Number of Broilers Per Hour									
	150	300	600	1,200	1,800	2,400	3,600	5,000	7,500	10,000
	(cents per pound, live weight basis)									
Plant wages[2]	2.880	2.350	1.993	1.761	1.612	1.501	1.391	1.338	1.255	1.190
Electricity, water	0.116	0.111	0.106	0.100	0.097	0.094	0.091	0.088	0.084	0.082
Variable repairs[3]	0.018	0.017	0.024	0.027	0.022	0.023	0.019	0.018	0.018	0.017
Wear depreciation[3]	0.103	0.095	0.138	0.156	0.126	0.130	0.111	0.101	0.101	0.097
Total variable operating costs	3.117	2.573	2.261	2.044	1.857	1.748	1.612	1.545	1.458	1.386
Supplies and materials	0.880	0.880	0.860	0.840	0.820	0.820	0.800	0.800	0.800	0.800
Total constant-unit operating costs	0.880	0.880	0.860	0.840	0.820	0.820	0.800	0.800	0.800	0.800
Management[4]	0.723	0.410	0.337	0.368	0.325	0.325	0.297	0.276	0.256	0.241
Miscellaneous	0.077	0.067	0.060	0.055	0.052	0.050	0.045	0.041	0.038	0.035
Heat, telephone	0.068	0.068	0.065	0.060	0.056	0.055	0.054	0.052	0.051	0.048
Total fixed operating costs	0.868	0.545	0.462	0.483	0.433	0.430	0.396	0.369	0.345	0.324
Depreciation[5]	0.114	0.094	0.096	0.095	0.081	0.078	0.072	0.064	0.062	0.059
Repairs, Maintenance[6]	0.054	0.043	0.042	0.040	0.035	0.034	0.029	0.027	0.026	0.024
Taxes, interest, ins.[7]	0.097	0.080	0.082	0.084	0.070	0.069	0.060	0.054	0.051	0.049
Total fixed overhead costs	0.265	0.217	0.220	0.219	0.186	0.181	0.161	0.145	0.139	0.132
Total costs	5.130	4.215	3.803	3.586	3.296	3.179	2.969	2.859	2.742	2.642
	(million pounds)									
Annual volume	1.0	2.1	4.1	8.3	12.4	16.6	24.9	34.6	51.9	69.2

[1] At 100% of capacity.
[2] Includes operating personnel, cleanup, maintenance, office help.
[3] To in-plant equipment other than ice machinery.
[4] Managerial, buying, selling, office managers, superintendents and foremen.
[5] All depreciation on buildings and ice machinery; time depreciation on other in-plant equipment.
[6] Repairs and maintenance to buildings and ice machinery; maintenance on other in-plant equipment.
[7] Buildings and equipment.

ing 69.2 million pounds annually through a broiler plant with a capacity of 10,000 birds per hour would cost $1,828,000. Costs for the same volume, processed through two plants of 5,000 broilers per hour capacity, would total $1,978,000, or $150,000 more.

Figure 5 shows a relatively smooth economies of scale curve except for the 1,200 broilers per hour plant. Although the average cost per pound at capacity (1,200) is lower than at capacity for the 600 size, the introduction of many types of mechanized equipment produces a slight deviation from a smooth, theoretical curve. However, these points apparently represent optimum levels for plants of these capacities. The combinations of labor and capital chosen, insofar as the dressing operation is concerned, are least-cost combinations determined by the partial budgeting technique.[11] The 1,200-size may not be an optimum capacity for the level of mechanization employed. Observation of plants which approximated this capacity when the study was begun indicates a shift toward larger sizes.

When the average cost curves for the 10 model plants are plotted in relation to percent of capacity (30 to 130 percent), unit costs are successively lower, almost without exception, for each percentage level as plant size increases. Relative advantages are minimized at 100 percent of capacity, but widen below and above this level (Figure 6). This suggests that each succesively larger plant has an advantage over the next smaller unit. Net differences in unit costs provide a measurement of the savings or increased revenues which the firm with the less efficient plant must accomplish by other means if it is to remain competitive.

Fowl

Economies of scale accruing to successively larger plants are considerably less with fowl than with broilers. The smaller number of head per hour are more than offset by the difference in weight per bird. Hence, average cost per pound for processing fowl in any plant is lower than for broilers.

The total unit cost difference from the high-cost (120 fowl per hour) plant to the low-cost (6,000) plant is only 1.386 cents per pound. Almost 85 percent of this saving occurs between the 120 and 480 fowl per hour plants. Between the 480 and 6,000 sizes, unit costs decline only 0.313 cents per pound, with a net difference in annual volume of 65.4 million pounds (Table 3). The difference in unit costs for fowl is substantially less than the 1.161 cents per pound savings between the comparable plants processing broilers which have a net difference in annual volume of 65.1 million pounds. The total dollar savings in processing a given quantity of fowl through a single larger plant rather than two or more smaller plants would still be substantial.

The larger plants would experience great difficulty in obtaining required quantities of fowl because of the smaller aggregate supply and its marked seasonality. Assembly costs would soon become prohibitive in most periods of the year. Hence, the discussion of economies of scale in processing fowl and other heavy birds become somewhat academic excluding plants with capacities of 3,000 per hour or less. Except in a typical situation and for smaller plants, such market classes are likely at best to be a supplement to supplies of broilers.

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[11] Univ. of N. H., Agric. Expt. Sta., Agric. Econ. Res. Mimeo No. 20, op. cit., p. 8-11

Table 3. Fowl: Per Pound Costs of Processing in Model Plants of Selected Capacities[1]

Item	Plant Capacity — Number of Fowl Per Hour									
	120	240	480	900	1.260	1.600	2.300	3.000	4.500	6.000
	(cents per pound. live weight basis)									
Variable operating costs	2.272	1.878	1.570	1.593	1.549	1.534	1.472	1.427	1.420	1.349
Constant-unit operating costs	0.860	0.860	0.840	0.820	0.800	0.800	0.780	0.780	0.780	0.780
Fixed operating costs	0.633	0.397	0.322	0.376	0.361	0.377	0.362	0.359	0.336	0.315
Fixed overhead costs	0.194	0.155	0.154	0.171	0.156	0.158	0.157	0.139	0.135	0.129
Total costs	3.959	3.290	2.886	2.960	2.866	2.869	2.771	2.705	2.671	2.573
	(million pounds)									
Annual volume	1.4	2.8	5.7	10.7	14.9	19.0	27.3	35.6	53.4	71.1

[1] At 100% capacity.

The economies of scale curve for fowl in Figure 7 is neither as smooth nor as pronounced as that for broilers. In fact, one might interpret two curves from the data shown; one for the 120 to 480 fowl per hour plants and another for the 900 size and above. The discrepancy between the 480 and 900 sizes occurs because of the introduction of additional mechanized equipment in the latter model. Since the calculations with respect to fowl represent the capacities of model broiler plants converted to processing fowl, it may be that the combinations of capital and labor are not optimum.

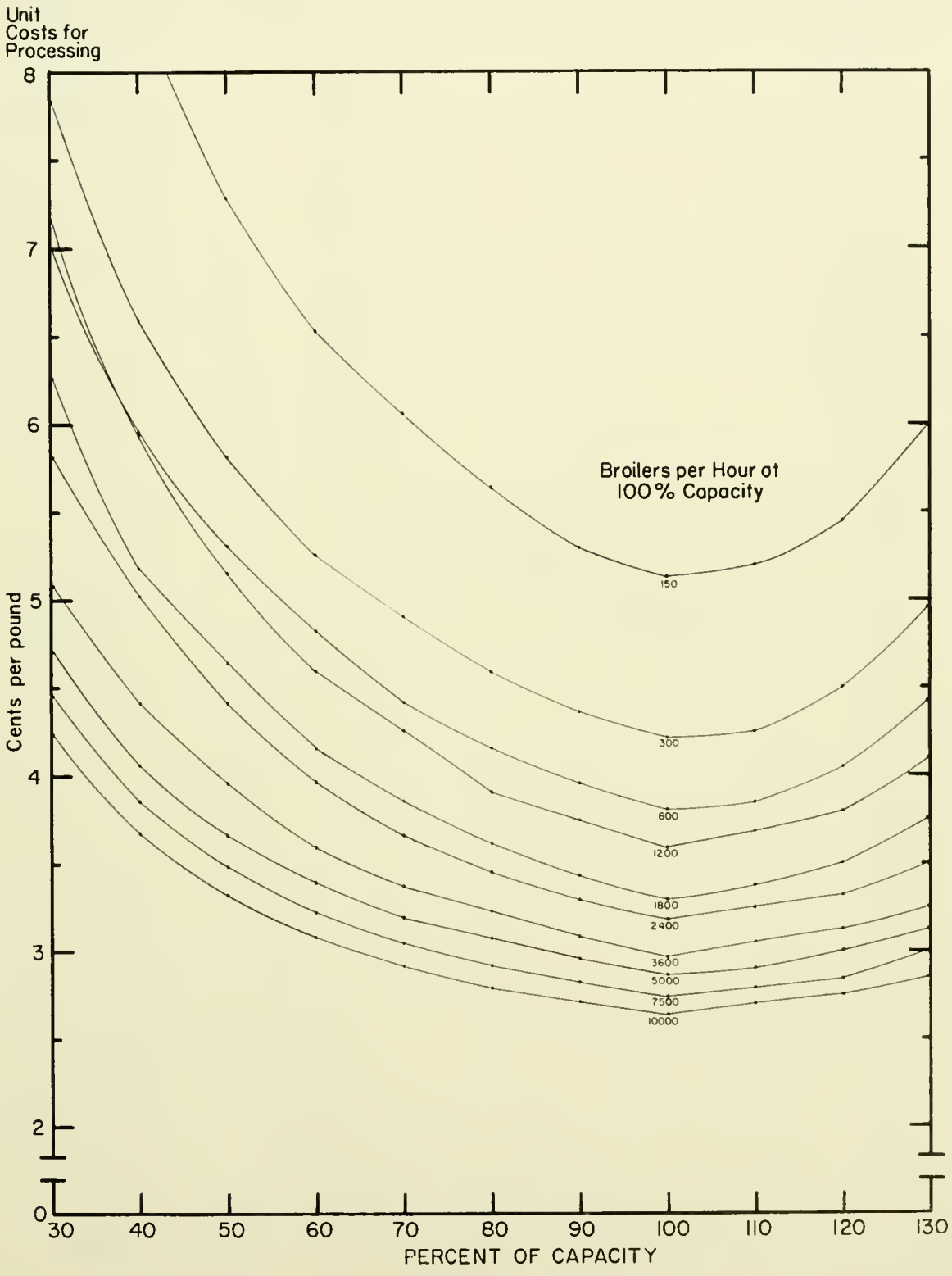

Figure 6. Broilers: Average Cost Curves for 10 Model Plants.

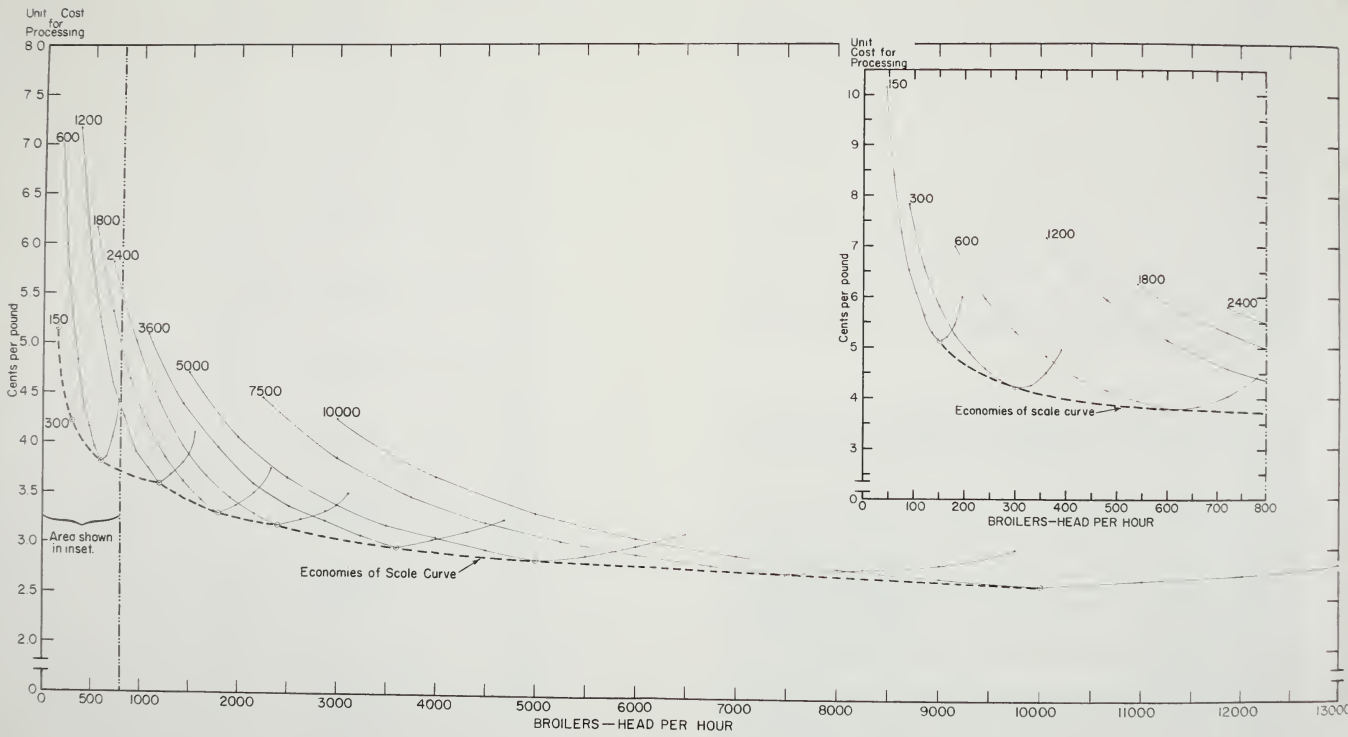

Figure 5. Broilers: Economies of Scale Curve and Average Cost Curves for 10 Model Plants.

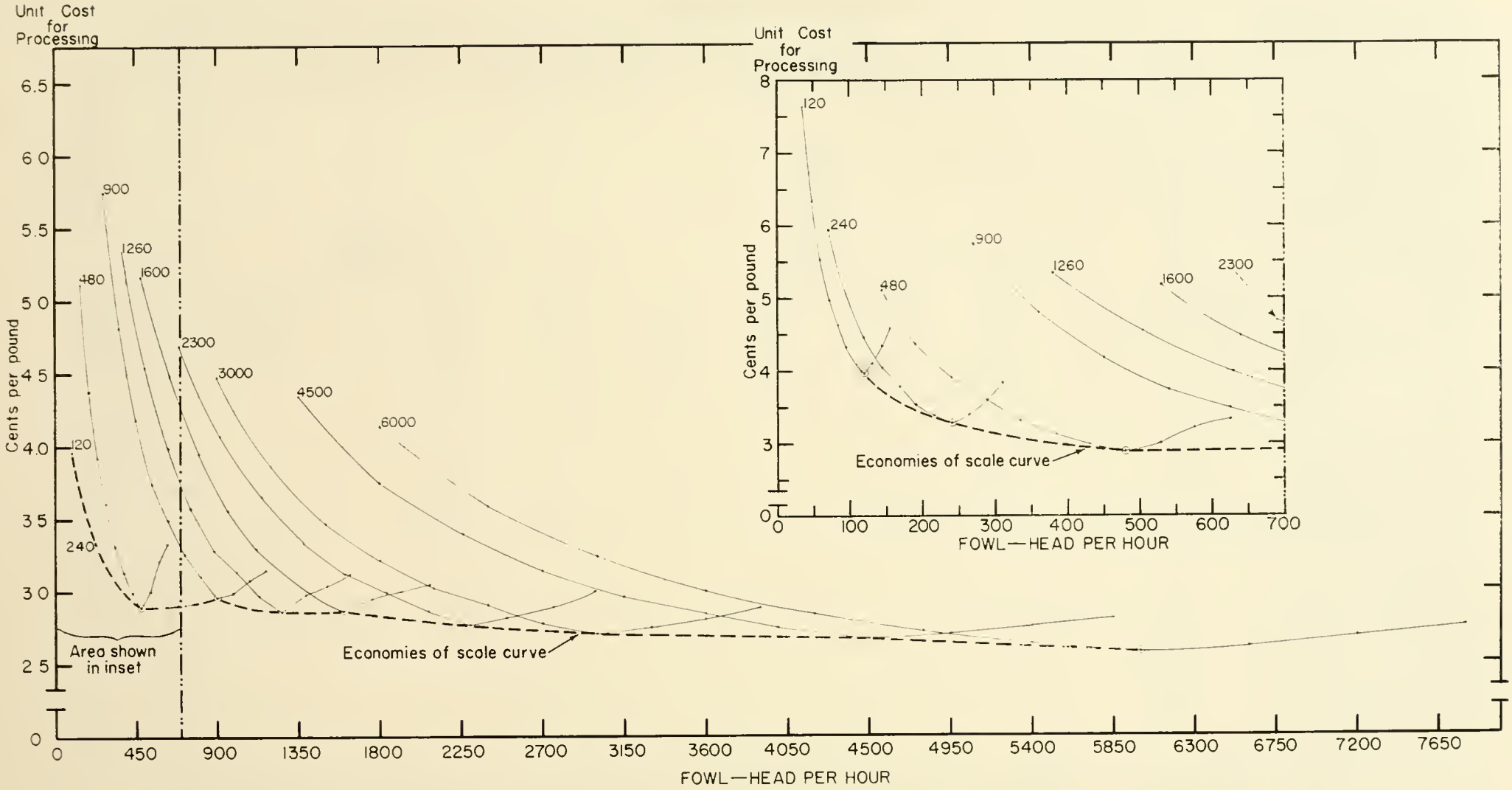

Figure 7. Fowl: Economies of Scale Curve and Average Processing Cost Curves for 10 Model Plants

When the average cost curves for the 10 model plants are plotted in relation to percentage of capacity for fowl (30 to 130 percent), unit costs are successively lower for each percentage level as plant size increases from 2,300 to 6,000 fowl per hour. A substantial difference exists from the 120 to 480 sizes. However, economies are irregular within the 480 to 1,600 range (Figure 8).

Importance of Cost Group in Producing Economies of Scale

Analysis of model plant costs was made in accordance with the groupings developed in Chapter II. All items do not contribute equally to establishing

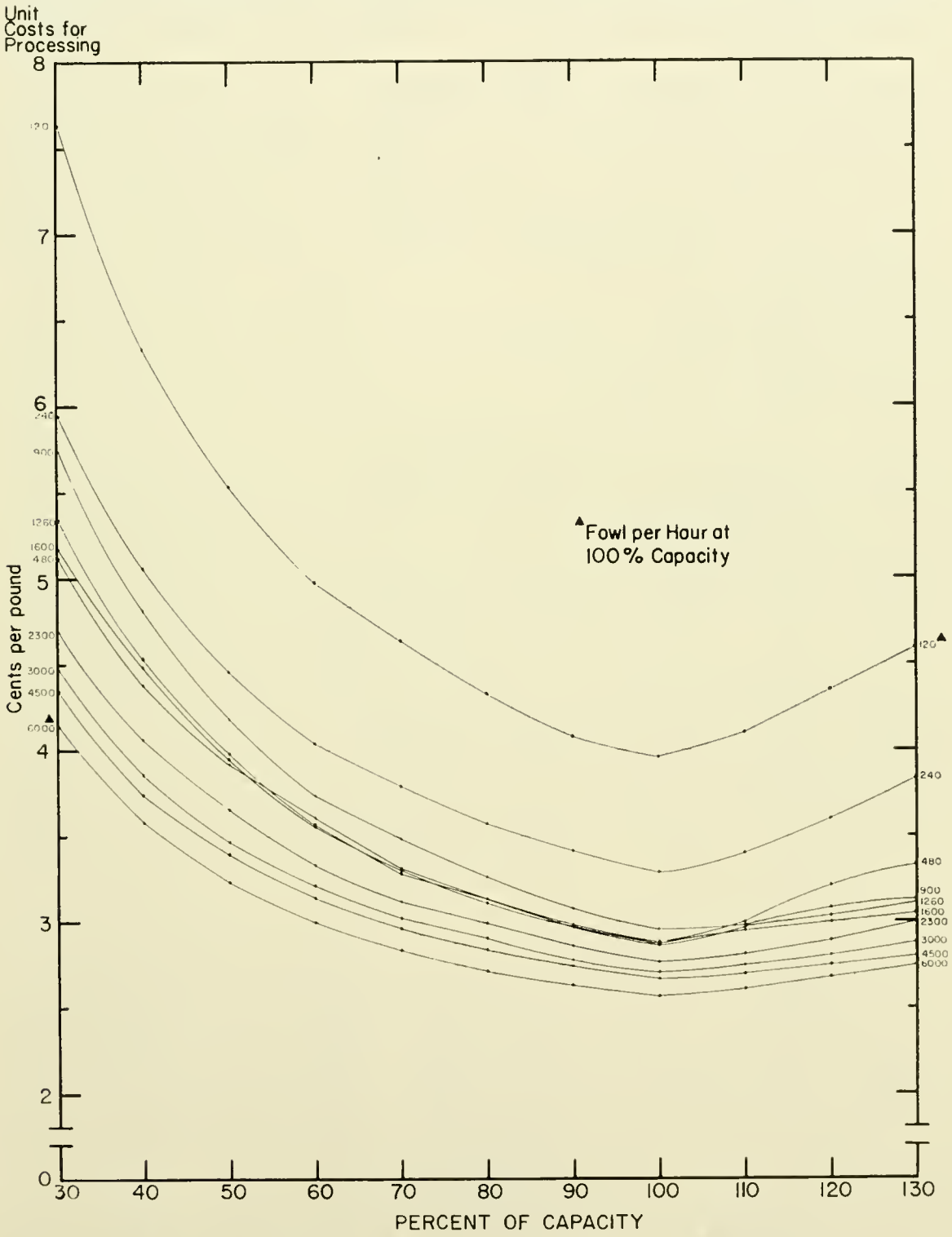

Figure 8. Fowl: Average Cost Curves for 10 Model Plants.

Table 4. Broilers: Relative Importance of Cost Items in Model Plants of Selected Capacities[1]

Item	Plant Capacity -- Number of Broilers Per Hour									
	150	300	600	1,200	1,800	2,400	3,600	5,000	7,500	10,000
	(percent of total unit costs)									
Plant wages	56.1	55.8	52.4	49.1	48.9	47.2	46.9	46.8	45.8	45.1
Supplies and materials	17.2	20.9	22.6	23.4	24.9	25.8	26.9	28.0	29.2	30.3
Management	14.1	9.7	8.9	10.3	9.9	10.2	10.0	9.7	9.3	9.1
Utilities, miscellaneous	5.1	5.8	6.1	6.0	6.2	6.3	6.4	6.3	6.3	6.2
Capital ownership and use	7.5	7.8	10.0	11.2	10.1	10.5	9.8	9.2	9.4	9.3
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[1] Operated at 100% of capacity.

economies of scale. Furthermore, management has little decision-making power with respect to some cost items.

Hence, the cost items in Tables 2 and 3 can be divided into two categories: (1) those which cannot be affected materially by managerial decisions of firms within particular size groups; and, (2) those wherein management can influence efficiency greatly. Table 4 represents such a regrouping of cost items. Supplies and materials, utilities and miscellaneous items fall within the first category; plant wages and salaries (management) and costs of capital ownership and use in the second category. Utilities include electricity, water, heat, and telephone. Costs of capital ownership and use include all repairs and maintenance, all depreciation, taxes, interest, and insurance.

Supplies and materials rank second to wages and salaries among processing plant cost groupings. Utilities and miscellaneous items constitute the smallest cost group. The decrease in unit cost for supplies and materials, over the full range of plant sizes studied, is .08 cents per pound, or 10 percent. While the relative decline for utilities and miscellaneous items is 37 percent, these costs aggregate only 5 percent to 6 percent of total costs.

Factor prices for supplies, materials, utilities and miscellaneous items are fixed by firms or agencies external to the processing plant. Furthermore, such items are consumed in processing at rates required by trade practices, sanitary requirements, or machine capacities. Hence, plant output per unit of input of these items cannot be materially affected by managerial decisions of firms within particular size groups.

Plant wages and salaries (management) and costs of capital ownership and use account for 78 percent of the unit costs of a broiler plant of 150 birds per hour capacity and 63 percent for a 10,000 broilers per hour unit. The total decline from the 150 to 10,000 plant sizes is 2.488 cents per pound. Of this amount, the above items account for 93 percent, or 2.312 cents per pound. Over the range of plant sizes studied, unit costs for wages and salaries decline 60 percent; capital costs 36 percent.

The balance of this chapter is devoted to a detailed discussion of costs of capital ownership and use and wages and salaries. Capital costs involve long-term investment in buildings and equipment. Allocation of limited capital among alternative uses involves a major area of decision-making. Plant management also has the opportunity, through organization of the working force and determination of optimum combinations of labor and capital, to realize major economies of scale.

Capital Investment

The estimated capital investment required for the model plants is substantial. For the two smallest model plants, 150 and 300 broilers per hour, the investment in the building and other related items, which depreciate over a relatively long period of time, exceeds that in equipment. At the 600 size, where mechanization begins to replace hand operations, the reverse is true. As plant size increases, investment in equipment climbs much more rapidly than investment in buildings and related items (Table 5).

Building Costs

There were two basic requirements in the planning of buildings for model plants: (1) to provide adequate working room for functions carried out

Table 5. Capital Investment Required for Model Plants

Item	Plant Capacity — Number of Broilers Per Hour									
	150	300	600	1,200	1,800	2,400	3,600	5,000	7,500	10,000
	(dollars)									
Dollar Investment:										
Building	8,503	12,104	20,514	35,944	43,164	50,613	60,401	69,364	93,514	114,557
Equipment	8,550	15,630	38,936	84,616	107,225	144,574	195,235	246,987	369,711	468,932
Misc.[1]	3,381	5,423	9,824	17,893	24,405	31,027	43,417	56,523	74,216	93,386
Total	20,434	33,157	69,274	138,453	174,794	226,214	299,053	372,874	537,441	676,875
Investment per pound of annual capacity:	(cents)									
Buildings and miscellaneous[2]	1.15	0.84	0.73	0.65	0.54	0.49	0.42	0.36	0.32	0.30
Total	1.97	1.59	1.67	1.67	1.40	1.36	1.20	1.07	1.03	0.98
Costs per pound of annual capacity for ownership and use:[3]										
Buildings and miscellaneous[2]	0.147	0.108	0.094	0.084	0.069	0.061	0.053	0.048	0.042	0.039
Total	0.386	0.329	0.382	0.402	0.334	0.334	0.291	0.264	0.258	0.246

[1] Land, artesian well and installation, office furniture and fixtures, refrigerator and equipment.

[2] See Table 7 for similar calculations for equipment.

[3] Based on 247 operating days of 8 hours each and 3.5 pounds per broiler, live weight basis.

and employee comfort; and, (2) to enable such plants to meet Federal inspection standards.[12]

Plants were constructed without expansion in mind, being adequate only for the particular volume level. Many of the newer poultry processing plants have been built specifically to permit future expansion. Hence, their overhead costs in the short-run might well exceed those established for the model plants. Planning for future expansion, to save major renovations later, might be a wise move, even though it would put the plant at a slight short-run cost disadvantage.

The model plants were assumed to have concrete floors with drains, concrete block walls (with impervious surfaces where required), steel casing windows and doors, wall ventilating fans and insulated or drip-proof ceilings under wood frame A-roofs or flat roofs with built-up roofing. In addition to building and equipment costs, Table 5 includes investment in land, an artesian well and its installation, office furniture and fixtures, and a refrigeration system.

Under the conditions prescribed, costs of buildings declined from about $5.21 to $3.27 per square foot of space within the 150 to 10,000 broilers per hour range (Table 6). Part of this decline is attributable to the decreased space requirements per unit of volume. Costs of refrigerator and ice space in addition to the basic room space included under building costs ranged from $3.12 to $1.87 per cubic foot within the range of plant sizes studied.

With plants operating at 100 percent capacity, and using rates given in Table 1, costs per pound for plant ownership and use (and including equipped refrigerator and ice rooms) decline from .147 cent per pound for the 150 broiler per hour plant to .069 cent for the 1,800 size and .039 cent for the 10,000 size (Table 5).

Costs of building materials, construction labor rates, and structural requirements are likely to vary from area-to-area. Hence, for areas outside New England, the pertinent aspects of the data in Table 5 may be the relative comparison rather than the absolute numbers and the data of Table 6.

Equipment Costs

Individual pieces of poultry processing equipment are manufactured in a limited number of sizes or capacities. A given combination of units of equipment often can be used to process various quantities with adjustments in the labor force, in line speed, and in shackle spacing. Thus, choice of the equipment used in a plant of a designated capacity should reflect the least-cost combination of equipment and labor.

In this study, beginning with model plants capable of processing 1,200 broilers per hour, and continuing through the 10,000 size, larger and/or additional pieces of similar equipment were added and overhead lines were lengthened. Likewise, feather and offal disposal systems and slush ice systems of larger capacities were installed.

Certain technology becomes economically feasible only as plants attain certain sizes. Hence, machine sizing: fork-lift trucks for use in unloading and in handling chill tanks; powered conveyors for facilitating the receiving and packing operations; mechanical box closers; and powered giblet

[12] *Regulations Governing the Inspection of Poultry and Poultry Products* (7 CFR Part 81), Poul. Div., Agr'l. Mktng. Service, U. S. Dept. of Agric., Issued 31 Jan. 1958.

Table 6. Space and Building Construction Costs for Model Plants

Item	Plant Capacity — Number of Broilers Per Hour									
	150	300	600	1,200	1,800	2,400	3,600	5,000	7,500	10,000
	(square feet)									
Receiving and Holding Area	528	850	1,456	2,040	2,600	3,000	3,400	3,780	4,320	5,184
Dressing Area	276	360	860	1,300	1,520	1,770	2,100	2,430	2,700	3,000
Eviscerating and Cutting-up Area	256	440	810	1,980	2,280	2,430	2,800	4,000	5,465	7,290
Sizing, Cooling, Packing, Shipping Area	246	377	706	1,632	2,020	2,852	3,750	4,650	6,164	8,064
Cooler and Ice Storage Area	70	136	280	568	780	1,044	1,470	1,957	2,858	3,780
Other Areas	256	432	708	1,720	2,190	2,664	3,365	4,310	6,283	7,672
Total, All Areas	1,632	2,595	4,820	9,240	11,390	13,760	16,885	21,127	27,790	34,990
Square Feet per Head per Hour	10.88	8.65	8.03	7.70	6.33	5.73	4.69	4.22	3.71	3.50
	(dollars)									
Plant Construction Cost[1]	8,503	12,104	20,514	35,944	43,164	50,613	60,401	72,832	93,514	114,557
Construction Costs per Square Foot	5.210	4.666	4.256	3.890	3.792	3.696	3.577	3.400	3.355	3.274

[1] Building only. Does not include land, office furniture, refrigerator and equipment, artesian well and installation nor plant equipment.

wrapping and stuffing equipment are included in the models at successive plant size stages.

Model plants capable of processing 600 broilers per hour and less are not mechanized to the same degree as larger plants. Minimum combined capital and labor costs exist with less mechanization and more hand labor. Appendix Table 1 shows the equipment used in the 10 model plants.

Inasmuch as the type of equipment and the extent of mechanization varies, the investment in equipment per pound of annual volume does not show a conclusive downward trend except from the plants designed for 2,400 broilers per hour and larger (Table 7). The 150 and 300 sizes are hand operations; the 600 plant has powered overhead conveyor lines but still employs some manual labor (side-line finisher) on feather removal. At the 1,200 size, machine sizing, feather and offal disposal systems and a slush ice system are the principle changes; these costs are offset by labor savings, so that the combined per-unit labor and capital costs decrease. With respect to ice, previous work indicated manufacturing ice preferable to buying ice, not only in terms of costs but also in terms of convenience. Point-of-use delivery of ice also resulted in labor savings.[13]

At capacity operations, costs per pound for equipment ownership and use do not show a continuous downward trend except from the 2,400 broiler per hour size through the 10,000 size. Unit costs of ownership and use of equipment are substantially larger than for buildings and related items since equipment is depreciated at a more rapid rate.

Equipment costs in this analysis were derived from data furnished by operating plants and by equipment-manufacturing firms. However, prices are subject to change over time and precise costs of freight and installation were difficult to determine from many plant records. Pricing practices employed by equipment-manufacturing firms include such features as trade-in allowances, installation help, and package deals when firms buy the entire line through one source. Since individual situations may vary greatly, equipment prices derived are probably relative rather than precise.

Despite the substantial dollar investments in equipment required, particularly for plants capable of processing 1,200 broilers per hour and up, the cost of acquiring and using equipment per unit of product is small in comparison with some other items. This substantiates the viewpoint expressed by many plant operators.

Plant Wages and Salaries

Plant wages account for 56 percent of total unit costs for plants capable of processing 150 broilers per hour, and 45 percent for the 10,000 size. Management costs (which include office and supervisory personnel) range from 14 to 9 percent of total unit costs for the 150 and 10,000 plants. The relative importance of wages and salaries decreases as plant size increases; other items tend to increase in relative importance (Table 4).

Operation of a processing plant with the minimum number of employees should not occur at the expense of quality, wholesomeness, or yield. The importance of yield can be illustrated by the following example: with live chickens valued at 18c per pound, each 1 percent increase in eviscerated

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[13] Univ. of N. H., Agric. Expt. Sta., Agric. Econ. Res. Mimeo. No. 20, op.cit., p 9, 11.

Table 7. Equipment Costs for Model Plants

Item	Plant Capacity — Number of Broilers Per Hour									
	150	300	600	1,200	1,800	2,400	3,600	5,000	7,500	10,000
	(dollars)									
Receiving, holding	1,442	2,728	4,997	8,141	10,246	18,569	22,369	25,319	38,269	45,369
Killing, dressing	1,475	3,025	15,031	31,355	38,445	45,340	57,739	69,781	113,488	146,779
Eviscerating, cutting-up	1,678	2,942	6,380	16,038	18,639	26,865	35,277	53,915	64,544	90,040
Sizing, cooling, packing, icing	3,955	6,935	12,528	29,082	39,895	53,800	79,850	97,972	153,410	186,744
Total	8,550	15,630	38,936	84,616	107,225	144,574	195,235	246,987	369,711	468,932
	(cents)									
Investment per pound of annual capacity[1]	0.82	0.75	0.94	1.02	0.86	0.87	0.78	0.71	0.71	0.68
Costs per pound of annual capacity[1] for equipment ownership and use	0.239	0.221	0.288	0.318	0.265	0.270	0.238	0.216	0.216	0.207

[1] Based on 247 operating days of 8 hours each and 3.5 pounds per broiler, live weight basis.

yield will decrease "shrinkage costs" by about 0.35 cents per pound.[14] For a plant rated at 5,000 broilers per hour, this saving would be equivalent to about one-fourth the annual payroll of operating personnel. A plant can well afford a few additional employees on the line and an efficient staff at the managerial, office and supervisory levels.

Labor Efficiency

The levels of labor efficiency attained in the model plants exceed those observed in actual plants. They are somewhat less than might be derived by synthesizing operations on the basis of job time studies or than is suggested by equipment manufacturing firms. One of the dangers involved in synthesizing operations from time studies or standards is that some contributing functions may be ignored.

Waste time on individual jobs is difficult to eliminate entirely. As plant size increases, a greater proportion of the labor force is employed at near-peak efficiency, but jobs cannot be adequately separated to achieve this status completely.[15] In actual plants, sporadic variations in volume, changing plant sizes, forms in which product is sold, and problems associated with labor turnover and training new employees limit efficiency.

The projected numbers of operating employees required in the 10 model plant sizes when operating at 100 percent of capacity are shown, by major functions in Table 8. The receiving, hanging, and killing functions also involve unloading and handling crates, crate repair, and the feeding incident to carrying an occasional load of birds in batteries. The dressing operation covers personnel to reverse birds where necessary, machine operators (including quill pullers on all lines), and pinners. The eviscerating operation includes transfer to that line, full drawing except kidneys, giblet handling, knife sharpeners, final inspectors (trimmers) and assistants to government inspectors. The latter are included at the rate of one per 1200-1500 birds. The sizing, cooling, packing, and shipping group includes removal from the eviscerating line and rehanging on the automatic sizer, packing, grading, weighing, marking, box closing, handlers, and box makers. Table 8 also includes the number of employees required for non-operating functions.

While the volume of broilers per hour increases 67 times from 150 to 10,000 per hour, relative increases in numbers of employees are much smaller. In terms of full-time (equivalent) employees the following rates of increase by function occur: receiving, hanging, killing, 30; dressing, 15; eviscerating, 31; cutting-up, 48; sizing, cooling, packing, shipping, 29; cleaning, repairing, maintenance, 10; supervision, 16; office, 22; management, 18. The lower the rate of increase in numbers of employees, the higher the resulting increase in output per employee.

Table 9 shows the output per worker in the 10 model plants both for broilers and fowl. Output per worker in the dressing function is 4 times

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[14] The term "shrinkage cost" is accepted industry terminology. Confronted with a specified market price, an increase in yield would increase revenue because the number of pounds marketed would be greater. In another sense, the overall margin between live cost and processed value can be affected by yield.

[15] This point was well illustrated in the following study: Gerald, J. O., and H. S. Kahle: *Marketing Georgia Broilers Through Commercial Processing Plants.* Mkt. Res. Rpt. No. 83. Agr'l. Mktg. Service, U.S.D.A. in cooperation with Georgia Expt. Sta., March 1955.

Table 8. Number of Employees Required in Model Plants by Major Functions[1]

Function	Status	Plant Capacity — Number of Broilers Per Hour									
		150	300	600	1,200	1,800	2,400	3,600	5,000	7,500	10,000
		(number of employees)									
Operating:											
Receiving, hanging, killing[2]	Full-time	—	1	2	6	6	7	11	16	23	30
	Part-time	2	1	2	—	1	2	1	—	—	—
Dressing	Full-time	—	—	—	6	8	9	12	16	23	30
	Part-time	4	6	9	—	—	1	—	—	—	—
Eviscerating	Full-time	5	8	13	25	36	44	67	89	125	158
	Part-time	—	—	1	—	—	5	—	—	—	—
Cutting-up[3]	Full-time	—	—	2	4	5	7	10	14	20	24
	Part-time	1	2	—	—	1	—	—	—	—	—
Sizing, cooling, packing, shipping	Full-time	—	—	—	9	12	15	19	25	34	43
	Part-time	3	5	9	—	1	—	1	—	—	—
Cleaning, repairing, maintenance	Full-time	1	1	2	3	3	4	5	6	8	10
	Part-time	—	1	—	—	1	—	—	—	—	—
Total operating	Full-time equivalent	11.0	17.5	29.5	53.0	72.0	90.0	125.0	166.0	233.0	295.0
Other:											
Supervision, foremen	Full-time	1	1	2	3	4	5	7	10	13	16
	Part-time	—	—	—	—	—	—	—	—	—	—
Office	Full-time	—	—	1	2	3	3	4	6	9	11
	Part-time	1	1	—	—	—	—	—	—	—	—
Management	Full-time	—	—	1	2	2	3	4	5	7	9
	Part-time	1	2	—	—	—	—	—	—	—	—
Total, other	Full-time equivalent	2.0	2.5	4.0	7.0	9.0	11.0	15.0	21.0	29.0	36.0
Total, all employees	Full-time equivalent	13.0	20.0	33.5	60.0	81.0	101.0	140.0	187.0	262.0	331.0

[1] With plants operated at 100% of capacity.
[2] Includes provision for holding one load of birds on occasion.
[3] Approximately 20% of volume assumed to be cut-up.

Table 9. Labor Output for Direct Processing Functions in Model Plants[1]

Function	Plant Capacity — Number of Broilers Per Hour									
	150	300	600	1,200	1,800	2,400	3,600	5,000	7,500	10,000
	(birds per hour per employee)									
Receiving, hanging, killing	150	200	200	200	277	300	313	313	326	333
Dressing	75	100	133	200	225	253	300	313	326	333
Eviscerating	30	37	44	48	50	52	54	56	60	63
Cutting-up	60	60	60	60	65	69	72	72	75	83
Cooling, sizing, packing, shipping	100	12	133	133	144	160	185	200	221	233
Average Output	15.0	18.7	21.8	24.0	26.3	27.9	30.0	31.3	33.3	35.1
	(pounds per hour per employee)									
Average Output	52.5	65.4	76.3	84.0	92.1	97.6	105.0	109.6	116.6	122.9
	Plant Capacity — Number of Fowl Per Hour									
	120	240	480	900	1,260	1,600	2,300	3,000	4,500	6,000
	(birds per hour per employee)									
Average Output	12.0	15.0	17.5	18.0	18.4	18.6	19.2	19.4	20.0	21.1
	(pounds per hour per employee)									
Average Output	72.0	90.0	105.0	108.0	110.4	111.6	115.2	116.4	120.0	126.6

[1] Employees engaged in functions directly related to processing. Excludes cleaning maintenance, supervision, office, and management.

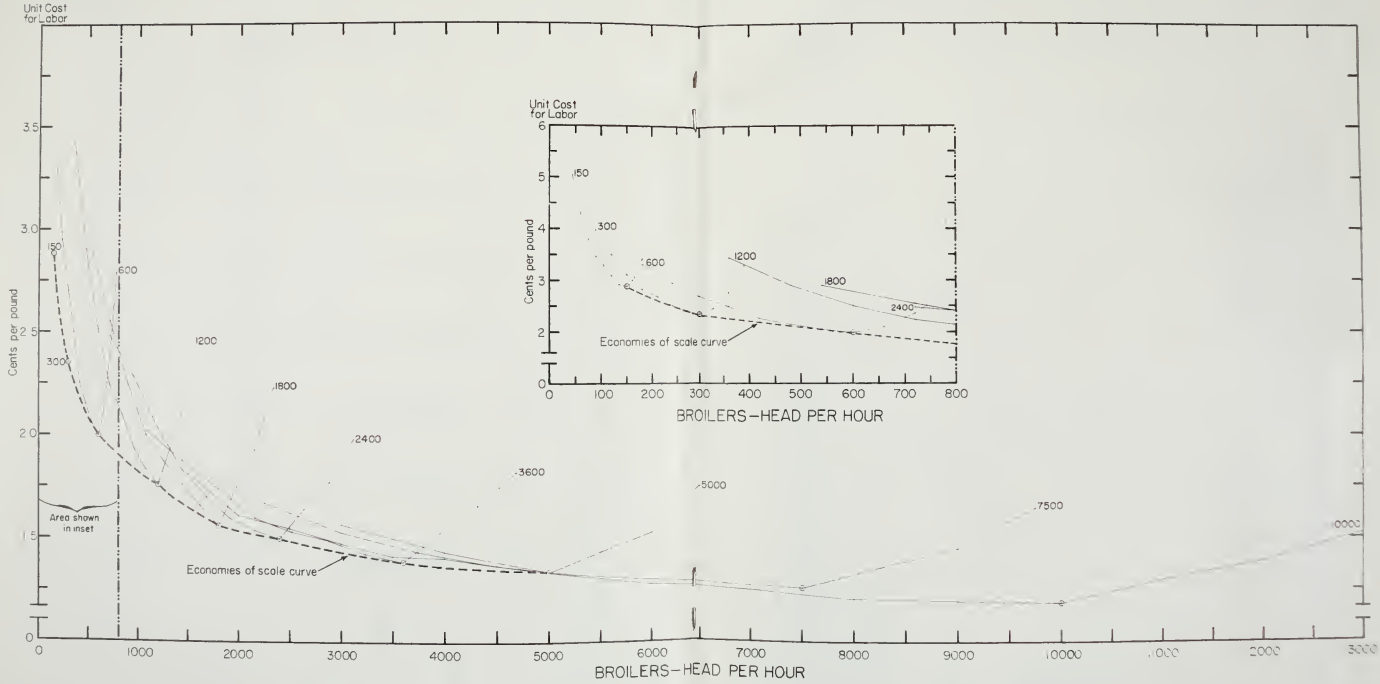

Figure 9. Broilers: Economies of Scale Curve and Average Labor Cost Curves for 10 Model Plants

Table 10. Number of Employees Required in Model Plants for Various Managerial, Office, and Supervisory Functions[1]

	Plant Capacity — Number of Broilers Per Hour									
	150	300	600	1,200	1,800	2,400	3,600	5,000	7,500	10,000
	(number of employees)									
Overall management[2]	)	)	)	1	1	1	2	3	3	3
Buyers[3]	) ½	) 1	) 1	)	)	1	1	1	2	3
Sellers	)	)	)	) 1	) 1	1	1	1	2	3
Office Managers	—	—	—	1	1	1	1	1	2	3
Office workers	½	½	1	1	2	2	3	5	7	8
Superintendents	—	—	—	—	—	)	1	1	1	1
Foremen — Receiving	—	—	)	)	)	) 1	)	1	1	2
— Dressing	—	—	) ½	) 1	) 1	)	) 1	1	1	2
— Eviscerating[4]	—	—	)	)	1	2	3	4	5	6
— Packing	—	—	) 1	) 1	)	)	)	1	1	1
— Shipping	—	—	)	)	) 1	) 1	) 1	1	1	1
— Cleaning	—	—	)	)	)	)	)	)	1	1
— Maintenance	—	—	) ½	) 1	) 1	) 1	) 1	) 1	1	1
Foremen — General	1	1	—	—	—	—	—	—	—	1
Total	2	2.5	4	7	9	11	15	21	29	36
	(number of broilers)									
Ratio: Head per hour per managerial employee	75.0	120.0	150.0	171.5	200.0	218.2	240.0	238.1	258.6	277.8
	(cents)									
Cost per pound of annual capacity[5]	0.72	0.41	0.34	0.37	0.33	0.33	0.30	0.28	0.26	0.24

[1] Full-time equivalents.
[2] Policy making, purchasing, scheduling, some buying and selling, personnel work, coordination of other functions in integrated organizations.
[3] In plants with contract growing programs, these individuals would be concerned with arranging and supervising in lieu of purchasing. In addition some field men for direct supervision of contract flocks would be needed.
[4] Includes cut-up.
[5] Based on 247 operating days of 8 hours each and 3.5 pounds per broiler, live weight basis.

greater at the 10,000 birds per hour level than at 150. For the receiving, hanging, and killing; cooling, sizing, packing, and shipping; and eviscerating functions the corresponding ratio is closer to 2:1. The cutting-up function shows the lowest rate of increase in output per worker as plant size increases. The number of birds processed per hour per employee increases from 15.0 to 35.1 from the 150 to 10,000 broilers per hour sizes, whereas the corresponding figures for the same plants processing fowl would be 12.0 and 21.1 (Table 9). Hence, the greatest relative advantage for large plants, insofar as labor efficiency is concerned, lies in processing broilers.

Plant wages are the largest item of cost in the operation of poultry processing plants. The effect of plant wages is important in producing a declining average cost curve.

The increased output per worker as volume increases to 100 percent of capacity substantially reduces unit labor costs. Beyond 100 percent of capacity, a combination of overtime wage rates and some declines in output per worker increases labor costs. It is the only element observed which causes average cost to increase beyond 100 percent of capacity. Average labor costs per pound for selected plant sizes and the existence of a clearly defined economies of scale curve for plant labor costs are shown in Figure 9.

Managerial Efficiency

Substantial economies in managerial, office, and supervisory functions are inherent in large-scale operations. These deserve more attention than they generally have been given. Their quality is indirectly reflected in efficiencies obtained in the operating departments. Plant operators regard the problem of obtaining an experienced supervisory group as one deterrent to multiple shift operations.

The development of poultry processing as a mass-volume business is still of fairly recent origin. Since it occurred to a considerable extent during a period of comfortable margins, management has probably not yet assumed its eventual role in increasing efficiency. The lack of consistently good and uniform records and the frequent dearth of essential information on which it can base decisions suggests "playing by ear" is still commonplace.

For many plants, management must maintain widespread trade contacts since selling is a daily job. This is because of the general lack of long-range sales arrangements or systems of outlets integrated into the firm structure. The "poultry buying" role of large firm management may become virtually non-existent with the increased control of supply through growing programs.

Processing firms do not entirely operate as independent entities. A rudimentary set of institutional mores seems to be emerging and groups of plants work jointly through associations or by less formal arrangements on advertising, promotion, and certain other activities.

Table 10 contains a suggested breakdown by job assignments for managerial functions. In terms of the number of birds per employee engaged in these functions, the ratio is almost 4:1 when comparing a 10,000 broiler per hour plant with the 150 size. Although salaries for specific jobs increase with plant size (see Appendix Table II), the decline in cost per pound of annual capacity (100 percent) as plant size increases is still important.

IV. Some Implications of Economies of Scale

The existence of economies of scale with present technology, and probable re-inforcement by new technology, is likely to exert increasing influence on the industry. However, the extent of this influence, and the time period over which it becomes operative, will be modified by institutional, firm, and area considerations.

In a previous report, several factors were enumerated as explanations of how firms of various sizes (and levels of efficiency of operation) could persist in an industry where economies of scale exist.[16] These factors determine and affect aggregate processing firm costs:

(1) Size of the supply and distribution areas;
(2) Supply sources and market outlets;
(3) Age and condition of the plant and equipment;
(4) Plant practices and volume;
(5) Location of the plant;
(6) Types and proportions of market classes handled;
(7) Processing stages carried out by unit;
(8) Importance of unpaid family labor.

Adjustments which individual firms will make to economies of scale in plant operations are likely to vary with plant size, with the nature of economies in assembling and distributing, and with the degree of integration involved. The study may have greater long-run than short-run application. Over time, external forces will become less significant.

In the long run, replacement of resources will nullify short-run cost advantages which now offset some of the inherent economies of scale. Buildings and equipment may become fully depreciated in terms of usefulness and need replacement at new cost. Increasing pressure will probably be brought to bear on plants by buyers to meet public sanitary or quality standards. Comparable quality and quantity of inputs would be necessitated, both in investment, and operating categories.

As plants strive to become larger and more efficient, volume sales prices will be relatively lowered. Other forces which could exclude smaller operators from additional outlets include: (1) Centralized buying, not only by corporate chains, but also by "independents" through cooperative wholesalers; (2) Disappearance of traditional consumer preferences which transcend price differences.

The number of processing units is likely to decrease and average size to increase. Thus, fewer resources per unit of output will be required in processing. But, the extent to which resources in processing will be reduced will be conditioned by assembling and distributing costs and by the location of production and the nature and degree of control upon it. Large plants will not entirely displace smaller units, although most factors point to a substantial decrease in their numbers.

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[16] Univ. of N. H., Agric. Expt. Sta., Agric. Econ. Res. Mimeo. No. 20, op. cit., p. 13, 15.

Systemic Efficiency

Substantial opportunities exist for increasing efficiency and reducing costs in the processing system. These can be achieved both by effecting efficiencies within individual plants and by altering the structure of the industry.

Cost estimates and capacities of model plants can be used to test the efficiency of the present processing system against alternative model systems. Two types of comparison are used here as measures of systemic efficiency: i.e., aggregate dollar costs of processing specified outputs, and numbers of units required and their potential capacity.

Table 11 shows the numbers of plants of each of the 10 model sizes used in this study which would have been required to process the 1957 New England chicken output. The total processing cost for each level is also presented. These calculations assume that 100 percent of the sales off farms would be eviscerated in processing plants.

About 427 million pounds (live weight) of the 1957 New England chicken output of 467.9 million pounds (live weight) was slaughtered within New England. About 2.5 million pounds of live poultry moved into New England and 46.1 million pounds of live poultry moved out of the area. The volume of live poultry bought by household consumers is insignificant.[17]

Of the 427 million pounds slaughtered in 1957 within New England, 84 percent was in 18 large plants. Of the remainder, 12 medium-sized plants accounted for 9 percent and 28 small plants for 3 percent. The balance of 4 percent, or 15.5 million pounds, was handled by 175 very small plants and 5 plants processing specialty items such as Rock-Cornish birds.[18]

About 290 of the 427 million pounds of slaughter was eviscerated in the same plants. The estimated aggregate dollar cost of processing for the present (1957) system, prior to the retail level, is estimated as $16.7 million. An additional volume of 20.0-25.0 million pounds was eviscerated by plants prior to the retail level at a cost of about $1 million.[19] Characteristics of the present system are summarized in Table 12.

If all the slaughtering plants in New England had been operated at 100 percent of capacity in 1957, 28 percent more volume could have been handled through the system. The 18 large plants alone could have accommodated the entire volume slaughtered in 1957 in the area (Table 12). In practice, attainment of 100 percent of capacity is difficult, but improvement of present rates of operation is neither impossible nor unlikely. Large plants as a group have led the way toward controlling supply by participating directly in contract growing programs or in informal arrangements. Hence, they are much closer to achieving capacity operation than smaller plants. This fact further increases their competitive advantage in processing under standardized conditions.

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[17] These data developed from information obtained in a study of the assembly of live poultry now in progress.

[18] The following intervals determined size classification:
Large: slaughter in excess of 8 million pounds annually.
Medium: slaughter between 1 and 8 million pounds annually.
Small: slaughter between 150,000 and 1 million pounds annually.
Very small: slaughter less than 150,000 pounds annually.

[19] This indicates more than two-thirds of New England slaughter was eviscerated prior to the retail level by 1957-58. A sample taken in 1955-56 indicated about two-fifths of volume eviscerated prior to the retail level.

Table 11. Number of Plants of Selected Sizes[1] Required to Process 1957 New England Chicken Output[2]

Plant Size (broilers per hour)	Number of Plants to Process Young Chickens[3]	Plant Size (fowl per hour)	Number of Plants to Process Mature Chickens[4]	Number of Plants to Process All Chickens[2]	Total Systemic Cost (mil. dollars)[5]
150	389.0	120	37.0	426.0	23.2
300	194.5	240	18.5	213.0	19.1
600	97.2	480	9.3	106.5	17.2
1,200	48.6	900	5.0	53.6	16.4
1,800	32.4	1,260	3.7	36.1	15.5
2,400	24.3	1,600	2.8	27.1	15.0
3,600	16.2	2,300	2.0	18.2	14.0
5,000	11.8	3,000	1.5	13.3	13.5
7,500	7.8	4,500	1.0	8.8	13.1
10,000	5.9	6,000	0.7	6.6	12.5

[1] Plants operated at 100% of capacity for 247 operating days of 8 hours each. 100% of volume eviscerated and 20% cut-up in processing plants.

[2] Young and mature chickens sold and commercial broilers produced by States, modes of State-by-State calculations on both head and pounds. State output data from "Chickens and Eggs: Farm Production, Disposition, Cash Receipts, Gross Income, by States, 1956-57; Chickens on Farms, January 1, by States, 1957-58; Commercial Broilers, by States, 1956-57". Agr'l. Mktng. Service, U. S. Dept. Agric. April 1958.

[3] Commercial broilers produced plus young chickens sold.

[4] Mature chickens sold.

[5] In calculating costs, plant numbers were rounded to the next highest whole unit. Unit costs were interpolated from Appendix Tables III and IV.

Table 12. Characteristics and Capacity of the Present System of Processing New England Chicken Output[1]

Plant Size and Type	Number of Plants	1957 Slaughter	Average Volume per Plant	Evisceration in Slaughtering Plants		Percent of Capacity at which Group Operated	Capacity of Present Plants if each Operated at 100 Percent of Capacity	
		(mil. lbs.)	(mil. lbs.)	(mil lbs.)	(percent)	(percent)	Total (mil. lbs.)	Per Plant (mil. lbs.)
Large	18	360.0	20.00	260.0	72	83.5	430.8	23.93
Medium	12	39.5	3.30	13.8	35	52.1	74.7	6.23
Small	28	12.0	0.43	2.4	20	33.9	36.0	1.29
Very small	175	7.0	0.04	5.3	75	20.0	35.0	.20
Other	5	8.5	1.70	8.5	100	50.0	17.0	3.40
Total	238	427.0	—	290.0	—	—	593.5	—
Average	—	—	1.79	—	68	72.0	—	2.49

[1] Model I in Table 13.

Under the present system of processing, costs aggregated an estimated $17.7 million on the basis of 1957 practices and numbers and types of firms (Table 13, Model I). If these same plants were to effect internal efficiencies to the extent determined in the 10 sizes of model plants discussed in Chapter III and to move to 100 percent evisceration within their plants, systemic costs would be reduced by $1.6 million (Table 13, Model II). Because of the addition of the eviscerating operation, increases would occur in unit costs and total costs of small and medium-sized plants now engaged solely in New York Dressing. But increased efficiency in large plants and elimination of evisceration by scattered separate plants would more than offset the increases for small and medium-sized plants.

If we had had the same volume processed in 1957 by each plant size group, but by a more limited number of plants operated at 100 percent of capacity, a further reduction of $2.0 million in systemic costs would have occurred. At the same time, plant numbers could have been 70 percent smaller (Table 13, Model III).

Many processing plants are likely to be expanded in capacity in future years. Such plans encompass expansions of supply through growing programs. Model IV in Table 13 presents some possible changes in numbers and sizes of plants and systemic costs which could occur commensurate with a 40 percent increase in volume of slaughter. Such an increase would be feasible in view of the growth of commercial meat production in recent years. A further shrinking of the movement of live birds out of New England is also likely.

These changes envisage fewer and larger processing plants and a continuing shift toward volume handling at other levels. With such a system there would be only 25 percent as many processing plants required as existed in 1957. The increased volume could be processed with only a 10 percent increase in aggregate costs over that which the 1957 system entailed (Table 13, Model I).[20]

Small Plant Survival

Despite a generally unfavorable outlook, some smaller plants may survive and thrive under certain circumstances. To evaluate these conditions from the marketing standpoint, studies of the assembly and distributive phases are required. However, it is possible from the study of economies of scale in plant operations, and also from knowledge of current market structure and practices, to outline some of the ways in which smaller processing plants can operate effectively and profitably. These can be classified under the following:

(1) Changes of status;
(2) Locational considerations:
(3) Modifying cost factors;
(4) Types of products and services.

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[20] Aggregative cost and volume data for portions of an industry are extremely useful in estimating current systemic costs. An effort should be made to develop additional estimates similar to those contained in the following release:

Saunders, R. *The Impact of the Broiler Industry on Maine's Economy.* Mimeo. Rpt. No. 75, Dept. Agr. Econ., Maine Agr. Exp. Sta., in cooperation with The Maine Poultry Associates, Inc., and the Maine Ext. Service. June 1958, p. 2-3.

Table 13. Number of Plants Required and Aggregate Costs of Alternative Model Systems of Processing New England Chicken Output

Plant Size and Type[1]	Model I		Model II[4]		Model III[5]		Model IV[6]		
	No. of[2] Plants	Processing Costs (mil dollars)	No. of Plants	Processing Costs (mil. dollars)	No. of Plants	Processing Costs (mil. dollars)	No. of Plants	Processing Costs (mil. dollars)	New Output (mil. lbs.)
Large	18	12.3	18	11.2	13.0	10.4	16	15.2	528.0
Medium	12	1.5	12	1.8	4.1	1.8	6	1.5	43.0
Small	28	0.5	28	0.8	8.0	0.5	9	0.5	12.0
Very small	175	0.9	175	0.8	35.0	0.4	25	0.4	5.0
Other	5	1.5	5	1.5	2.5	1.0	5	1.8	10.0
Total	238	17.7[3]	238	16.1	62.6	14.1	61	19.4	598.0

[1] Under each interval plants of different sizes occur.

[2] This distribution based on actual records of a substantial sample of plants.

[3] Includes allowance for evisceration in non-slaughtering plants prior to retail level. Based on actual costs incurred by a sample of plants of various sizes. See Table 12 for additional characteristics of present system. 1957 output.

[4] Same number and distribution of plants as in Model I, operated at same percent of capacity, but with 100 percent of slaughter eviscerated in slaughtering plants. Costs based on efficient model units as interpolated from Appendix Tables III and IV. 1957 output.

[5] Based upon the operation of the most efficient plants within each size group at 100 percent of capacity. 1957 output. Costs based on Appendix Tables III and IV.

[6] Projected requirements for the future with volume increased 25 percent over 1957 levels. Based upon some increases in plant sizes within the "large" group, but on a similar percent distribution of sizes within other groups. Plants in all size groups except "other" operated at 90 percent of capacity. Costs based on Appendix Tables III and IV.

Three courses of action may be open to the small plant operator relative to changing status: (1) expand the size of his own plant to obtain economies of scale: (2) combine with other operators to achieve efficiencies through greater volume and/or specialization: (3) become a part of an integrated organization. Declining numbers of live buyers and processors may afford remaining firms, particularly smaller ones in low-volume, more distant producing areas, the opportunity to expand volume. Under some conditions several small operators might find it advantageous to combine to: (a) pool resources and utilize a larger centralized eviscerating plant fed by several small dressing plants; (b) establish a new corporation to carry on straight-line evisceration: (c) eliminate duplications in supply and distributing areas; (d) each specialize in performing specific functions such as assembly, processing, and distributing.

Initiation of a production (growing) program for broilers, other young meat chickens, and/or turkeys would provide increased, more stable, and more uniform live poultry for the plant. This could help lower costs. Further developments could include hatchery and feed mill operations in the integrated organization.

Locational considerations play an important part in the prospects of many small plants. The existence of large areas of "non-commercial" poultry production enhances the possibility that small plants can survive in them. Large firms may find it to their advantage to by-pass such territory. This may leave small operators without much competition and with relatively favorable operating margins for the smaller, scattered, and mixed lots of poultry found in these areas. High assembly costs for large firms and live buyers can enhance the competitive advantage of the small operator located in the area and may offset, in part, higher plant operating costs.

Selling prices of processed poultry in "non-commercial" poultry producing areas, particularly if they are deficit, may become more closely related to wholesale-lot selling prices at large plants plus inbound handling and transportation costs. In addition, small firms may widen their overall operating margin by engaging in local distributing to jobbing and retail outlets.

Unit costs derived in the economies of scale analysis assumed uniform wage rates and credited value to all labor required at the prescribed rates. Resources and practices were also standardized. In practice, factor prices, such as wage rates, may be lower in some smaller plants. The use of substantial amounts of family labor may also reduce the cash cost component especially if wages paid family members are lower. Existing plants may be able temporarily to use buildings and equipment already depreciated or acquire them at a portion of new cost. So long as they do not engage in interstate commerce and become subject to compulsory Federal Inspection, operate in areas where State and local regulations are less stringent, or are not adversely affected by buyer reaction, costs can be curtailed somewhat. Use of second-hand crates and less ice in packing for nearby buyers may also reduce costs. However, most of these measures should be viewed as short-run expedients.

Most smaller plants currently operate at a lower rate of capacity than larger plants. To the extent that they can solve their supply problems, they can improve their present position. Concentration on market classes other than broilers may offer such an opportunity for small plants. This may

extend from specialty items such as "Rock-Cornish game hens" and non-chicken classes such as ducks, geese, guineas, turkeys, pigeons and game birds,[21] as well as roasting chickens, fowl, and roosters. The prospects for obtaining fowl are dependent to a considerable extent on location, and upon the number of smaller egg producers who remain in business and who do not process their own birds.

Some market may still remain for small plants solely because of consumer preferences. These may be religious or ethnic in association, or the residual demand for "native, fresh-killed" birds in which physical nearness to processing is a determinant.

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[21] Pigeons and game birds are not subject to the Poultry Products Inspection Act, but they may be processed in official plants operating under inspection. Inspection of pigeons and game birds can be applied to processors who voluntarily request this service under provisions of the Agricultural Marketing Act of 1946.

V. Changes Required to Enable Plants to Produce Eviscerated Poultry Under Inspection

Recent trends indicate that evisceration at country plants is increasing rapidly in New England. The Poultry Products Inspection Act will abet this trend. Many plants face the prospects of converting from production of dressed to eviscerated birds and of making improvements in plants and operations to comply with Federal Inspection standards or with more stringent State or local regulations.[22]

Model plants developed in Part III of this report were designed to dress and eviscerate chickens under conditions which would meet Federal Inspection requirements. In a previous report, a more limited number of model plants were designed for New York Dressing. Conditions in these plants approximated those in some of the more efficient plants observed, but it was recognized that changes would be required before the model plants could meet Inspection requirements.[23]

Comparison of these two sets of model plants should provide a basis for reference in:

(1) Estimating costs of conversion from a dressed to an eviscerated product;

(2) Estimating costs of conversion from non-inspected to inspected status;

(3) Determining the magnitude of the additional resources required to expand plant capacity where feasible;

(4) Measuring impacts on the industry, including probable effects on the competitive position of plants of various capacities.

Space Requirements and Building Costs

Most New England poultry processing plants now have excess bird holding capacity. Plants built some years ago generally held birds on feed for about 24 hours prior to slaughter. Thus, the New York Dressing model plants included substantial holding areas (Table 14). Recently, the practice of feeding has declined and most plants now slaughter out of crates. Birds are held in batteries infrequently. In appraising the alternatives of established plants, existing resource levels (in terms of space) play an important part. These areas can be made suitable for other uses by minor renovations. Additional money must also be spent to enable plants to meet Inspection requirements. These changes are most likely to involve walls, partitions, ceilings, and additional plumbing, sewage, lighting, and ventilating facilities.

Plants with capacities of 2,400 and 5,000 broilers per hour built for New York Dressing, and including sufficient holding capacity for a day's

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[22] For additional information see: Brasfield, K. H., and R. D. Wenger, Remodelling Small Poultry Plants to Meet Inspection Requirements, AMS-256. Mktg. Res. Div. Agr'l. Mktng. Service, U. S. Dept. Agric., June 1958.

[23] Univ. of N. H., Agric. Expt. Sta., Agric. Econ. Res. Mimeo. No. 20, op. cit., p. 1-3.

Table 14. Space and Building Construction Cost for Model New York Dressing Plants[1]

Item	Plant Capacity — Number of Broilers Per Hour					
	150	300	600	1,200	2,400	5,000
	(square feet)					
Receiving and holding area[2]	702	1,280	2,400	4,300	7,875	15,000
Dressing area[3]	702	914	1,553	3,280	5,463	9,090
Cooler and ice storage area	70	136	280	568	1,017	1,957
Other areas[4]	230	378	607	1,210	2,055	3,749
Total, all areas[5]	1,704	2,708	4,840	9,358	16,410	29,796
	(dollars)					
Refrigerator cost	2,184	3,929	7,336	13,518	22,577	39,923
Building cost	8,554	12,105	19,844	34,999	56,779	96,837
Building cost per square foot[5]	5.02	4.47	4.10	3.74	3.46	3.25

[1] Source: Table 1, Univ. of N. H., Agric. Exp. Sta., Agric. Econ. Res. Mimeo. No. 20. March 1958. p. 5. Revised to include comparable technology to that employed for subsequent plants designed to eviscerate also.

[2] Includes space for batteries, crates, cleaning, feed storage. Does not include outside receiving platforms.

[3] Includes killing, dressing, cooling, packing, compressor and boiler areas.

[4] Offices, feather holding, box storage, toilets, lunch rooms.

[5] Not including outside receiving platform in square feet.

Table 15. Area and Costs of Buildings for Model New York Dressing and Eviscerating Plants

Plant Capacity (no. of broilers per hour)	New York Dressing Plants				Eviscerating Plants		Cost Difference: remodelled N.Y.D. plant minus eviscerating plant
	Area	New Cost[1]	Alteration Cost[2]	Adjusted Cost	Area	New Cost	
	(sq. ft.)	(dollars)	(dollars)	(dollars)	(sq. ft.)	(dollars)	(dollars)
150	1,704	8,554	426	8,980	1,632	8,503	+ 477
300	2,708	12,105	650	12,755	2,595	12,104	+ 651
600	4,840	19,844	1,089	20,933	4,820	20,514	+ 419
1,200	9,358	34,999	1,872	36,871	9,240	35,944	+ 927
1,800	—	—	—	—	11,390	43,164	—
2,400	16,410	56,779	2,954	59,733	13,760	50,613	+ 9,120
3,600	—	—	—	—	16,885	60,401	— 668
5,000	29,796	96,837	4,767	101,604	21,127	72,832	+ 28,772
7,500	—	—	—	—	27,790	93,514	+ 8,090
10,000	—	—	—	—	34,990	114,557	—

[1] Cost when built for New York dressing, including holding capacity for a full day's operation.

[2] Cost of remodelling to qualify for Inspection and permit adding eviscerating operation.

operation, could be developed into straight-line eviscerating units of larger capacity under present practices. With only a nominal area retained for holding purposes, the 2,400 size would accommodate a capacity of more than 3,000 birds per hour. The available space would be slightly less than for the 3,600 eviscerating model. The 5,000 size (New York Dressing model) would accommodate a capacity of at least 7,500 broilers per hour in terms of the eviscerating model units (Table 15).

The effects on unit costs are related to the level of prices of building materials involved. Obviously, if plants built in earlier years when building costs were substantially lower are remodelled, both the book value of total investment and the resulting unit cost would be less than for new plants built at current price levels, provided the present buildings are of good sound construction and in good physical condition.

The model plants in Table 14 were synthesized using current price levels. Thus, the new total investment in buildings for remodelled New York Dressing plants of 150 to 1,200 broilers per hour capacity slightly exceed that for plants of similar capacity built new for straight-line eviscerating. But at the 2,400 and 5,000 sizes, investment in buildings of the renovated model plants considerably exceeds that in the new model eviscerating plants of the same capacity. This occurs because of the substantial excess of space in the holding areas of the New York Dressing model plants designed for 2,400 and 5,000 broilers per hour. Hence, to equate per unit investment in buildings with those of new plants for eviscerating, capacity should be increased.

If, at current price levels, investment in buildings is translated into depreciation, repairs and maintenance, taxes, interest, and insurance, and reduced to cost per pound of product at capacity, differences in favor of newly-constructed eviscerating model plants compared with converted New York Dressing plants become negligible.

Equipment Costs

Aggregate investment in plant equipment[24] for model eviscerating plants exceeds that for model New York Dressing plants. These differences are shown in Table 16, and range from $179 to $25,363 for the 150 and 5,000 broilers per hour sizes, respectively.

If sufficient equipment to accommodate the eviscerating and cutting-up (20 percent of volume) operations is added to the New York Dressing model plants, as originally determined, the investment cost in equipment for such units would exceed that for comparable eviscerating model units. These calculated differences range from $1,499 to $28,552 for the 150 and 5,000 size units, respectively. When these differences in favor of the eviscerating model plants are reduced to cost per pound of product at capacity they become negligible (.051 to .027 cent per pound within the 150-5,000 range). Furthermore, these differences result mainly from the larger investment in holding batteries in the New York Dressing model plants. Plants customarily depreciate batteries over a relatively short period. Hence, the differences are likely to persist only for a short time.

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[24] Excluding refrigerator and equipment. In the two sets of models these costs were considered separately from those for building and plant equipment, and were about the same for plants of comparable capacity.

Table 16. Investment in Equipment Required for Model New York Dressing and Eviscerating Plants

Type of Plant and Equipment	Plant Capacity — Number of Broilers Per Hour							
	150	300	600	1,200	2,400	3,600	5,000	7,500
	(dollars)							
New York Dressing:								
Total[1]	8,371	15,219	36,053	80,124	135,184	—	221,624	—
Eviscerating:								
Eviscerating, cutting-up	1,678	2,942	6,380	16,038	26,865	35,277	53,915	64,544
Other[1]	6,872	12,688	32,556	68,578	117,709	159,958	193,072	305,167
Total	8,550	15,630	38,936	84,616	144,574	195,235	246,987	369,711
N.Y.D. "Total" minus Eviscerating "Total"	— 179	— 411	— 2,883	— 4,492	— 9,390	—	— 25,363	—
N.Y.D. models plus equipment for eviscerating, and cutting-up	10,049	18,161	42,433	96,162	162,049	—	275,539	—
Preceding item minus Eviscerating "Total"	+ 1,499	+ 2,531	+ 3,497	+ 11,546	+ 17,475	—	+ 28,552	—

[1] Receiving, holding, killing, dressing, sizing, cooling, packing, icing. Eviscerating plants contain some additional mechanized equipment.

Table 17. Labor Force Required for Model New York Dressing and Eviscerating Plants

Type of Plant and Types of Employees	Plant Capacity — Number of Broilers Per Hour							
	150	300	600	1,200	2,400	3,600	5,000	7,500
	(no. of people: full-time equivalent)							
New York Dressing:								
Operating	5.0	7.5	12.0	20.0	33.5	—	68.0	—
Management	1.0	1.5	2.0	3.0	5.0	—	9.0	—
Total	6.0	9.0	14.0	23.0	38.5	—	77.0	—
Eviscerating:								
Operating	11.0	17.5	29.5	53.0	90.0	125.0	166.0	233.0
Management	2.0	2.5	4.0	7.0	11.0	15.0	21.0	29.0
Total	13.0	20.0	33.5	60.0	101.0	140.0	187.0	262.0
Net change (+)	7.0	11.0	19.5	27.0	62.5	—	110.0	—

Table 18. Comparison of Unit Costs in Model Plants Producing New York Dressed and Eviscerated Broilers and Fowl

Item	Plant Capacity (head per hr.)	New York Dressed		Eviscerated	
		Costs per Pound[1] (cents)	Index	Costs per Ponnd[2] (cents)	Index
Broilers	150	1.55	187	3.38	200
	300	1.30	157	2.79	165
	600	1.14	137	2.48	147
	1,200	1.06	128	2.26	134
	2,400	0.91	110	1.93	114
	5,000	0.83	100	1.69	100
Fowl	120	1.15	142	2.47	157
	240	0.94	116	2.03	129
	480	0.85	105	1.72	110
	900	0.84	104	1.76	112
	1,600	0.80	99	1.69	108
	3,000	0.81	100	1.57	100

[1] Capital, labor (operating, cleaning, maintenance, office), ice, power (partial) and water Source: Table 4, Univ. of N. H., Agric. Exp. Sta., Agric. Econ. Res. Mimeo. No. 20. May 1958, p. 12.

[2] Capital, labor (operating, cleaning, maintenance, office), ice, electricity and water.

To move from 2,400 to 3,600 and from 5,000 to 7,500 broilers per hour, as the analysis of space requirements and building costs indicated is desirable, an additional investment would be required. These amounts approximate $50,000 and $125,000 respectively.

Labor Force Required

A third major impact of changing from producing New York Dressed to eviscerated birds and from non-inspected to inspected status involves the labor force required. Table 17 summarizes these changes. Some of the increase in operating personnel results from increased maintenance, repair, and cleaning requirements. An additional increment reflects added personnel to assist Federal Inspectors. However, most of the increase reflects added plant functions. Management personnel increases reflect greater requirements for supervisory, clerical, and overall management functions.

Impacts on Costs and Economies of Scale

Previous analyses indicate that present plants of good construction will experience little difficulty or cost in meeting Inspection requirements. Most of the impact on plant costs is associated with addition of the eviscerating and cutting-up operations.

Although the dollar investment required to meet Federal Inspection may seem sizeable, it does not translate to significant increases in unit costs. Admittedly, the New York Dressing model plants used for comparative purposes in this chapter represent better-than-average units. Nevertheless, even a several-fold increase in building costs over those projected could occur without measurably affecting unit costs.

Addition of the evisceration operation, including the increase in equipment and labor force which it necessitates, cannot be attributed to Federal Inspection requirements. Superimposing the eviscerating and cutting-up operations about doubles the total unit costs for capital ownership and use, operating labor, electricity, ice, and water. Comparison of the two sets of model plants with respect to these costs (Table 18) shows a widening of the absolute cost differences between plants of various capacities when these operations are added. The addition of the eviscerating and cutting-up operations does not improve the relative competitive position of smaller plants.

The real impact of changing from uninspected to inspected status and/or from producing New York Dressed to eviscerated birds will depend on the current level of efficiency of the individual unit. In practice, few units approached the levels of efficiency projected for either set of model plants. Hence, if most units would maximize internal economies, changeover costs might be more than offset.

Appendix Table I. Types, Sizes, and Numbers of Units of Equipment for 10 Model Plants

Item		Plant Capacity — Number of Broilers Per Hour									
		150	300	600	1,200	1,800	2,400	3,600	5,000	7,500	10,000
Batteries	no.	5	9	18	27	27	45	45	45	45	45
Crates	no.	100	200	400	800	1,200	1,600	2,400	3,000	4,500	6,000
Hand trucks[1]	no.	1	2	3	3	4	2	3	4	6	8
Fork-lift trucks[2]	no.	—	—	—	—	—	2	2	2	4	4
Overhead lines:											
Dressing	no.	—	—	1	1	1	1	1	1	2	2
Eviscerating	no.	—	—	1	1	1	1 divided	2	2 divided	4	3 divided
Cutting-up[3]	in use	no	no	no	yes	yes	yes	yes	yes	yes	yes
Feather disposal system	in use	no	no	no	yes	yes	yes	yes	yes	yes	yes
Offal disposal system	in use	no	no	no	yes	yes	yes	yes	yes	yes	yes
Ice system[4]	type	flake	flake	flake	slush	slush	slush	slush	slush	slush	slush
Killing		(1)	(2)	line	line	line	line	line	line	line	line
Bleeding tunnel	ft.	(table)	(tables)	10′	20′	25′	30′	40′	60′	2–40′	2–60′
Scalder[5]	ft.	dunk	batch	10′	20′	25′	30′	40′	60′	2–40′	2–60′
Mechanical pickers	no.	1[6]	2[6]	2[7]	2	3	3	4	5	8	10
Quill pullers	no.	—	—	1	1	1	1	2	2	4	4
Hock & neck scalders	no.	—	—	—	2–5′	2–8′	2–8′	2–10′	2–10′	4–10′	4–10′
Singer, mech.	no.	—	—	1	1	1	1	1	1	2	2
Washer, dressing	no.	—	—	1	1	1	1	1	1	2	2
Giblet removal	type	table	table	line	line	line	line	line	line	line	line
Gizzard skinner	no.	1	1	1	1	1	1	1	2	2	3
Gizzard washer	no.	—	—	—	—	—	1	1	2	2	3
Mech. giblet pkg.	no.	—	—	—	—	—	—	1	2	2	3
Autom. head cutter	in use	no	no	no	no	no	yes	yes	yes	yes	yes
Washer, evisc.	no.	—	—	1	1	1	1	1	2	2	3

Cooling tank	no.	6	10	20	20	30	40	60	80	120	160
Circulating devices	no.	—	—	—	8	12	15	24	30	45	60
Automatic sizer	in use	no	no	no	yes	yes	yes	yes	yes	yes	yes
Mech. box closer	in use	no	no	no	no	no	no	yes	yes	yes	yes
Mech. conveyors:											
Receiving	in use	no	no	no	no	no	no	yes	yes	yes	yes
Pack & load	in use	no	no	no	no	no	no	yes	yes	yes	yes

[1] For use in receiving and shipping.
[2] For use in receiving, moving cooling tank, shipping.
[3] Over belt-type table.
[4] Point of use delivery with slush. Automatic box icer with larger sizes.
[5] Line scalders generally looped.
[6] Manually operated buffers.
[7] 1 rougher and 1 manually operated double side-line finisher.

Appendix Table H. Assumed Scale of Annual Salaries per Person for Management, Office and Supervisory Functions

Function	Plant Capacity — Number of Broilers Per Hour									
		150	600	1,200	1,800	2,400	3,600	5,000	7,500	10,000
Management	4,500	5,000	6,000	7,500	8,500	10,000	10,000	10,000	10,000	10,000
Buyers	—	—	—	6,000	7,000	7,500	7,500	7,500	7,500	7,500
Sellers	—	—	—	6,000	7,000	7,500	7,500	7,500	7,500	7,500
Office Managers	—	—	—	4,000	5,000	5,000	5,000	5,000	5,000	5,000
Office Workers	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]
Superintendents	—	—	—	—	6,000	6,000	6,000	6,000	6,000	6,000
and Foremen	—	—	—	5,000	5,000	5,000	5,000	5,000	5,000	5,000
	3,000	3,500	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000

[1] $1.25 per hour including fringe benefits. Time and a half over 40 hours per week.

Appendix Table III. Per Pound Costs, by Major Groups and in Total, for Processing Broilers in Model Plants operated at Various Percentages of Capacity[1]

Plant Capacity (number of broilers per hour) and Cost Group	Percent of Capacity										
	30	40	50	60	70	80	90	100	110	120	130
	(cents per pound — live wt. basis)										
150:											
Variable operating costs	5.500	4.670	4.133	3.758	3.556	3.341	3.159	3.117	3.289	3.622	4.248
Constant-unit operating costs	0.880	0.880	0.880	0.880	0.880	0.880	0.880	0.880	0.880	0.880	0.880
Fixed operating costs	2.891	2.169	1.735	1.446	1.239	1.084	0.964	0.868	0.789	0.723	0.667
Fixed overhead costs	0.889	0.668	0.534	0.443	0.381	0.332	0.296	0.265	0.242	0.225	0.204
Total Costs	10.160	8.387	7.282	6.527	6.056	5.637	5.299	5.130	5.200	5.450	5.999
300:											
Variable operating costs	4.421	3.854	3.412	3.101	2.937	2.759	2.634	2.573	2.676	2.986	3.497
Constant-unit operating costs	0.880	0.880	0.880	0.880	0.880	0.880	0.880	0.880	0.880	0.880	0.880
Fixed operating costs	1.815	1.362	1.089	0.908	0.778	0.681	0.605	0.545	0.495	0.454	0.419
Fixed overhead costs	0.722	0.496	0.433	0.363	0.310	0.272	0.239	0.217	0.199	0.180	0.165
Total Costs	7.838	6.592	5.814	5.252	4.905	4.592	4.358	4.215	4.250	4.500	4.961
600:											
Variable operating costs	3.859	3.388	3.073	2.824	2.578	2.441	2.338	2.261	2.367	2.621	3.037
Constant-unit operating costs	0.860	0.860	0.860	0.860	0.860	0.860	0.860	0.860	0.860	0.860	0.860
Fixed operating costs	1.543	1.157	0.925	0.771	0.661	0.578	0.514	0.462	0.421	0.386	0.356
Fixed overhead costs	0.735	0.552	0.443	0.369	0.313	0.275	0.242	0.220	0.202	0.183	0.172
Total Costs	6.997	5.957	5.301	4.824	4.412	4.154	3.954	3.803	3.850	4.050	4.425
1200											
Variable operating costs	3.982	3.354	2.906	2.586	2.413	2.189	2.125	2.044	2.202	2.377	2.718
Constant-unit operating costs	0.840	0.840	0.840	0.840	0.840	0.840	0.840	0.840	0.840	0.840	0.840
Fixed operating costs	1.611	1.208	0.966	0.805	0.690	0.604	0.537	0.483	0.439	0.403	0.372
Fixed overhead costs	0.729	0.545	0.438	0.366	0.314	0.274	0.242	0.219	0.199	0.180	0.170
Total Costs	7.162	5.947	5.150	4.597	4.254	3.907	3.744	3.586	3.680	3.800	4.100
1800:											
Variable operating costs	3.376	2.934	2.577	2.303	2.145	2.021	1.918	1.857	1.991	2.065	2.453
Constant-unit operating costs	0.820	0.820	0.820	0.820	0.820	0.820	0.820	0.820	0.820	0.820	0.820
Fixed Operating costs	1.446	1.085	0.868	0.723	0.620	0.542	0.482	0.433	0.394	0.361	0.334
Fixed overhead costs	0.623	0.467	0.373	0.310	0.266	0.233	0.209	0.186	0.170	0.154	0.143
Total Costs	6.265	5.306	4.638	4.156	3.851	3.616	3.429	3.296	3.375	3.500	3.750

Appendix Table III. Continued

Plant Capacity (number of broilers per hour) and Cost Group	Percent of Capacity										
	30	40	50	60	70	80	90	100	110	120	130
	(cents per pound — live wt. basis)										
2400:											
Variable operating costs	2.958	2.669	2.363	2.130	1.971	1.870	1.798	1.748	1.876	2.001	2.210
Constant-unit operating costs	0.820	0.820	0.820	0.820	0.820	0.820	0.820	0.820	0.820	0.820	0.820
Fixed operating costs	1.436	1.077	0.862	0.718	0.615	0.538	0.479	0.430	0.392	0.359	0.331
Fixed overhead costs	0.599	0.452	0.360	0.301	0.257	0.224	0.200	0.181	0.162	0.150	0.139
Total Costs	5.813	5.018	4.405	3.969	3.663	3.452	3.297	3.179	3.250	3.320	3.500
3600:											
Variable operating costs	2.424	2.221	2.037	1.863	1.778	1.730	1.660	1.612	1.745	1.862	2.021
Constant-unit operating costs	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800
Fixed operating costs	1.321	0.989	0.792	0.660	0.565	0.496	0.440	0.396	0.359	0.329	0.306
Fixed overhead costs	0.536	0.403	0.323	0.268	0.231	0.201	0.180	0.161	0.146	0.134	0.124
Total Costs	5.081	4.413	3.952	3.591	3.374	3.227	3.080	2.969	3.050	3.125	3.250
5000:											
Variable operating costs	2.189	1.972	1.831	1.731	1.659	1.631	1.581	1.545	1.635	1.772	1.932
Constant-unit operating costs	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800
Fixed operating costs	1.232	0.924	0.739	0.616	0.528	0.462	0.411	0.369	0.336	0.308	0.284
Fixed overhead costs	0.481	0.362	0.290	0.242	0.206	0.180	0.161	0.145	0.129	0.120	0.109
Total Costs	4.702	4.058	3.660	3.389	3.193	3.073	2.953	2.859	2.900	3.000	3.125
7500:											
Variable operating costs	2.038	1.841	1.711	1.611	1.550	1.512	1.483	1.458	1.550	1.635	1.831
Constant-unit operating costs	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800
Fixed operating costs	1.152	0.864	0.691	0.576	0.494	0.432	0.384	0.345	0.314	0.288	0.266
Fixed overhead costs	0.465	0.349	0.277	0.233	0.201	0.174	0.156	0.139	0.126	0.117	0.103
Total Costs	4.455	3.854	3.479	3.220	3.045	2.918	2.823	2.742	2.790	2.840	3.000
10000:											
Variable operating costs	1.928	1.735	1.607	1.517	1.467	1.420	1.402	1.386	1.486	1.571	1.700
Constant-unit operating costs	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800
Fixed operating costs	1.081	0.811	0.649	0.541	0.463	0.405	0.360	0.324	0.295	0.270	0.249
Fixed overhead costs	0.438	0.328	0.264	0.219	0.188	0.163	0.147	0.132	0.119	0.109	0.101
Total Costs	4.247	3.674	3.320	3.077	2.918	2.788	2.709	2.642	2.700	2.750	2.850

[1] Total Unit Costs data for Figure 6.

Appendix Table IV. Per Pound Costs, by Major Groups and in Total, for Processing Fowl in Model Plants Operated at Various Percentages of Capacity[1]

Plant Capacity (number of Fowl per hour) and Cost Group	Percent of Capacity										
	30	40	50	60	70	80	90	100	110	120	130
	(cents per pound — live wt. basis)										
120:											
Variable operating costs	4.015	3.405	3.015	2.737	2.590	2.441	2.300	2.272	2.489	2.800	3.099
Constant-unit operating costs	0.860	0.860	0.860	0.860	0.860	0.860	0.860	0.860	0.860	0.860	0.860
Fixed overhead costs	2.109	1.581	1.265	1.054	0.904	0.791	0.703	0.633	0.575	0.527	0.487
Fixed overhead costs	0.648	0.485	0.389	0.323	0.279	0.243	0.216	0.194	0.176	0.163	0.146
Total Costs	7.632	6.331	5.529	4.974	4.633	4.335	4.079	3.959	4.100	4.350	4.592
240:											
Variable operating costs	3.232	2.817	2.489	2.258	2.140	2.018	1.916	1.878	2.034	2.277	2.551
Constant-unit operating costs	0.860	0.860	0.860	0.860	0.860	0.860	0.860	0.860	0.860	0.860	0.860
Fixed operating costs	1.324	0.993	0.794	0.662	0.567	0.496	0.441	0.397	0.361	0.331	0.305
Fixed overhead costs	0.526	0.397	0.317	0.263	0.226	0.199	0.175	0.155	0.145	0.132	0.122
Total Costs	5.942	5.067	4.460	4.043	3.793	3.573	3.392	3.290	3.400	3.600	3.838
480:											
Variable operating costs	2.685	2.347	2.131	1.971	1.793	1.702	1.621	1.570	1.725	1.975	2.120
Constant-unit operating costs	0.840	0.840	0.840	0.840	0.840	0.840	0.840	0.840	0.840	0.840	0.840
Fixed operating costs	1.074	0.805	0.644	0.537	0.460	0.403	0.358	0.322	0.293	0.268	0.248
Fixed overhead costs	0.513	0.384	0.306	0.255	0.218	0.191	0.172	0.154	0.142	0.127	0.119
Total Costs	5.112	4.376	3.921	3.603	3.311	3.136	2.991	2.886	3.000	3.210	3.327
900:											
Variable operating costs	3.107	2.623	2.269	2.009	1.885	1.752	1.653	1.593	1.671	1.803	1.904
Constant-unit operating costs	0.820	0.820	0.820	0.820	0.820	0.820	0.820	0.820	0.820	0.820	0.820
Fixed operating costs	1.253	0.940	0.752	0.626	0.537	0.470	0.418	0.376	0.342	0.313	0.289
Fixed overhead costs	0.567	0.428	0.341	0.283	0.242	0.213	0.191	0.171	0.157	0.144	0.131
Total Costs	5.747	4.811	4.182	3.738	3.484	3.255	3.082	2.960	2.990	3.080	3.144
1260:											
Variable operating costs	2.815	2.448	2.151	1.914	1.790	1.689	1.597	1.549	1.709	1.809	1.823
Constant-unit operating costs	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800
Fixed operating costs	1.205	0.904	0.723	0.602	0.471	0.452	0.402	0.361	0.329	0.301	0.278
Fixed operating costs	0.519	0.389	0.310	0.258	0.220	0.196	0.173	0.156	0.142	0.130	0.119
Total Costs	5.339	4.541	3.984	3.574	3.281	3.137	2.972	2.866	2.980	3.040	3.120

Appendix Table IV. Continued

Plant Capacity (number of Fowl per hour) and Cost Group	Percent of Capacity										
	30	40	50	60	70	80	90	100	110	120	130
	(cents per pound — live wt. basis)										
1600:											
Variable operating costs	2.592	2.347	2.077	1.869	1.733	1.643	1.583	1.534	1.662	1.754	1.848
Constant-unit operating costs	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800
Fixed operating costs	1.256	0.942	0.754	0.628	0.538	0.471	0.419	0.377	0.343	0.314	0.290
Fixed overhead costs	0.524	0.395	0.318	0.263	0.224	0.197	0.174	0.158	0.145	0.132	0.122
Total Costs	5.172	4.484	3.949	3.560	3.295	3.111	2.976	2.869	2.950	3.000	3.050
2300:											
Variable operating costs	2.214	2.018	1.857	1.706	1.616	1.578	1.518	1.472	1.577	1.688	1.827
Constant-unit operating costs	0.780	0.780	0.780	0.780	0.780	0.780	0.780	0.780	0.780	0.780	0.780
Fixed operating costs	1.205	0.904	0.723	0.603	0.517	0.452	0.402	0.362	0.329	0.301	0.278
Fixed overhead costs	0.492	0.367	0.296	0.245	0.209	0.185	0.164	0.157	0.134	0.121	0.115
Total Costs	4.691	4.069	3.656	3.334	3.122	2.995	2.864	2.771	2.820	2.890	3.000
3000:											
Variable operating costs	2.028	1.832	1.692	1.603	1.531	1.504	1.445	1.427	1.516	1.633	1.716
Constant-unit operating costs	0.780	0.780	0.780	0.780	0.780	0.780	0.780	0.780	0.780	0.780	0.780
Fixed operating costs	1.198	0.898	0.719	0.599	0.513	0.449	0.399	0.359	0.327	0.299	0.276
Fixed overhead costs	0.468	0.351	0.281	0.235	0.201	0.175	0.156	0.139	0.127	0.118	0.108
Total Costs	4.474	3.861	3.472	3.217	3.025	2.908	2.780	2.705	2.750	2.810	2.880
4500:											
Variable operating costs	1.988	1.791	1.673	1.573	1.513	1.474	1.447	1.420	1.493	1.576	1.659
Constant-unit operating costs	0.780	0.780	0.780	0.780	0.780	0.780	0.780	0.780	0.780	0.780	0.780
Fixed operating costs	1.120	0.840	0.672	0.560	0.480	0.420	0.373	0.336	0.305	0.280	0.258
Fixed overhead costs	0.451	0.338	0.272	0.228	0.192	0.171	0.149	0.135	0.122	0.114	0.103
Total Costs	4.339	3.749	3.397	3.141	2.965	2.845	2.749	2.671	2.700	2.750	2.800
6000:											
Variable operating costs	1.877	1.696	1.568	1.479	1.430	1.384	1.364	1.349	1.427	1.533	1.629
Constant-unit operating costs	0.780	0.780	0.780	0.780	0.780	0.780	0.780	0.780	0.780	0.780	0.780
Fixed operating costs	1.051	0.788	0.631	0.526	0.450	0.394	0.350	0.315	0.287	0.263	0.243
Fixed overhead costs	0.426	0.318	0.255	0.212	0.181	0.160	0.141	0.129	0.116	0.104	0.098
Total Costs	4.134	3.582	3.234	2.997	2.841	2.718	2.635	2.573	2.610	2.680	2.750

[1] Total Unit Costs data for Figure 8.

Appendix Table V. Equipment and Facilities in Model Plants

Figure I. Plant (150 per hour)

1. Receiving Scale — portable
2. Kill and Bleed
3. Table
4. Hot Water Heater
5. Scalder (hand dunk)
6. Drain Tables
7. Manual Buffer
8. Pinning Shackles
9. Table
10. Cooling Tank
11. Basket Scale
12. Flake Ice Machinery and Storage

Figure II. Plant (600 per hour)

1. Receiving Scale — portable
2. Hang
3. Kill
4. Blood Trough — 20′
5. Scalder — 20′
6. Rougher
7. Wing Stripper
8. Side-line Buffer
9. Pinning Area
10. Singer
11. Washer
12. Transfer
13. Giblet Stations
14. Gizzard Cleaning Table
15. Washer
16. Take-off
17. Giblet Stuffing
18. Packing Scale
19. Ice and Close Boxes
20. Flake Ice Machinery and Storage

Figure III. Plant (2,400 per hour)

1. Receiving Scale — floor
2. Hang
3. Kill
4. Blood Trough — 60′
5. Scalder — 60′
6. Pickers — 3
7. Wing Stripper — double
8. Scalders — 8′
9. Feather Disposal System
10. Offal Disposal System
11. Pinning Area
12. Singer
13. Washer
14. Transfer
15. Inspection Stations
16. Giblet Stations
17. Giblet Packing Table
18. Washer
19. Giblet Stuffing
20. Transfer
21. Sizer
22. Box Scale
23. Box Icer
24. Close boxes
25. Head Puller

Figure IV. Plant (7,500 per hour)

1. Receiving Scale — floor (2)
2. Hang
3. Kill
4. Blood Trough — 80′
5. Scalder — 80′ (2)
6. Pickers — 4 each line
7. Wing Strippers — 2 double each line
8. Scalders — 8′
9. Feather Disposal System
10. Offal Disposal System
11. Pinning Area
12. Singers
13. Washers
14. Transfer
15. Inspection Stations
16. Giblet Stations
17. Giblet Packing Station
18. Washers
19. Giblet Stuffing
20. Take-off
21. Sizer
22. Box Scale
23. Box Icer
24. Box Closer
25. Head Pullers

Numbers in this table refer to numbers on the model plant layouts.

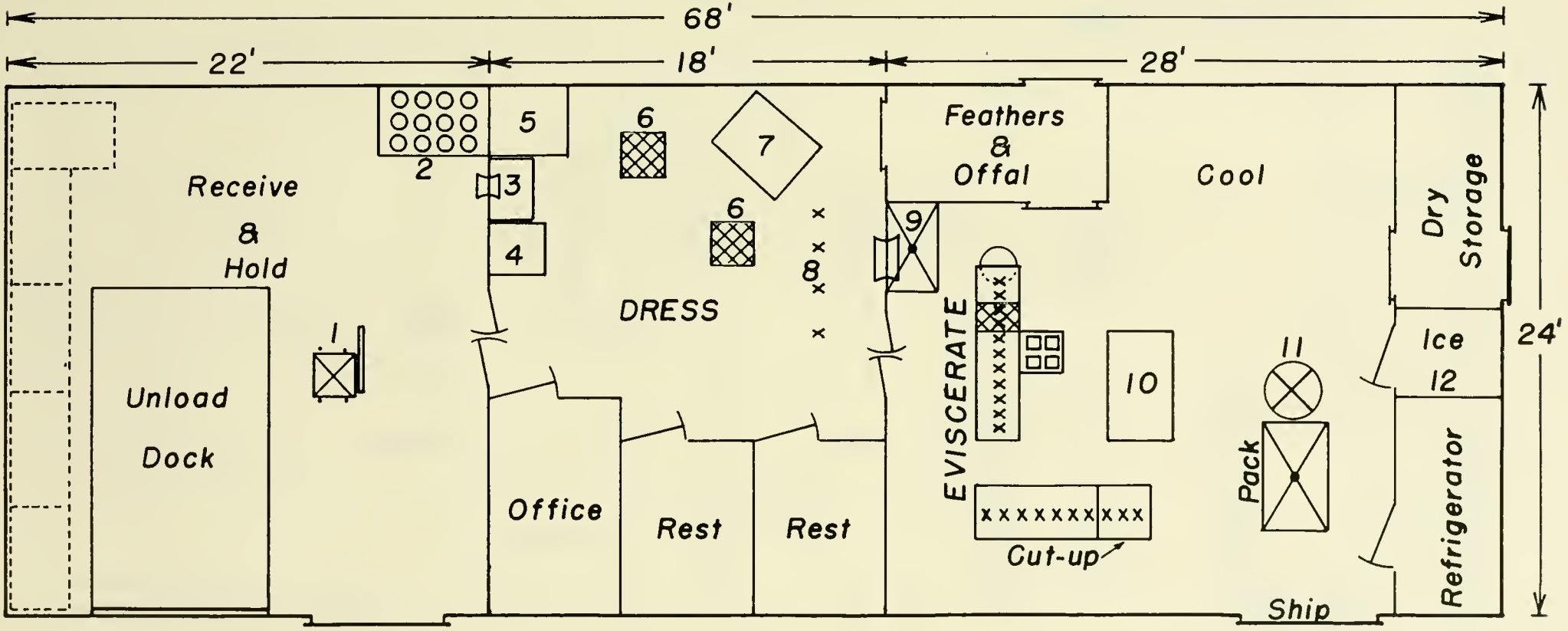

FIGURE I
MODEL PLANT
150 Broilers per hour

Scale=16 feet

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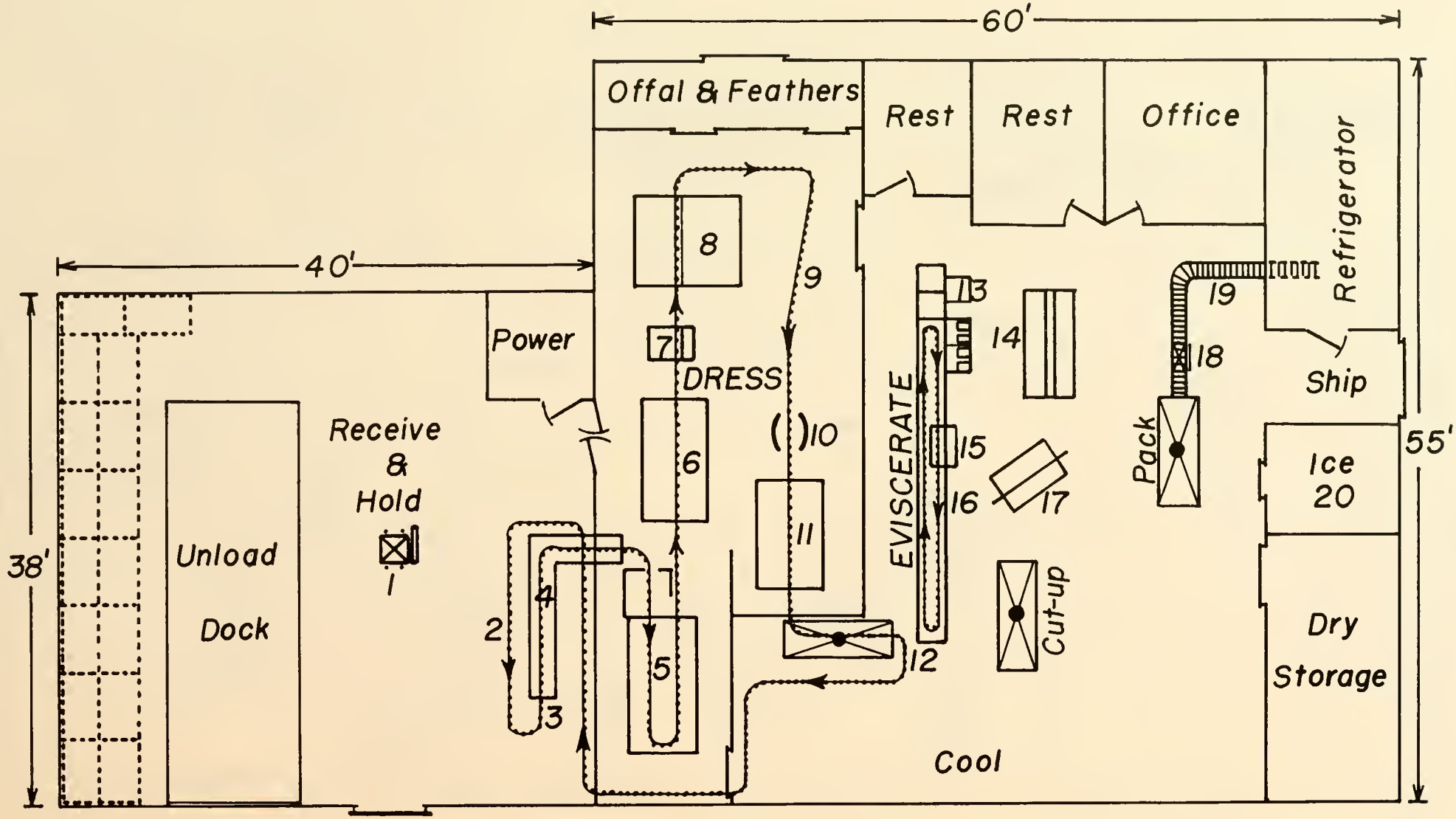

FIGURE II
MODEL PLANT
600 Broilers per hour

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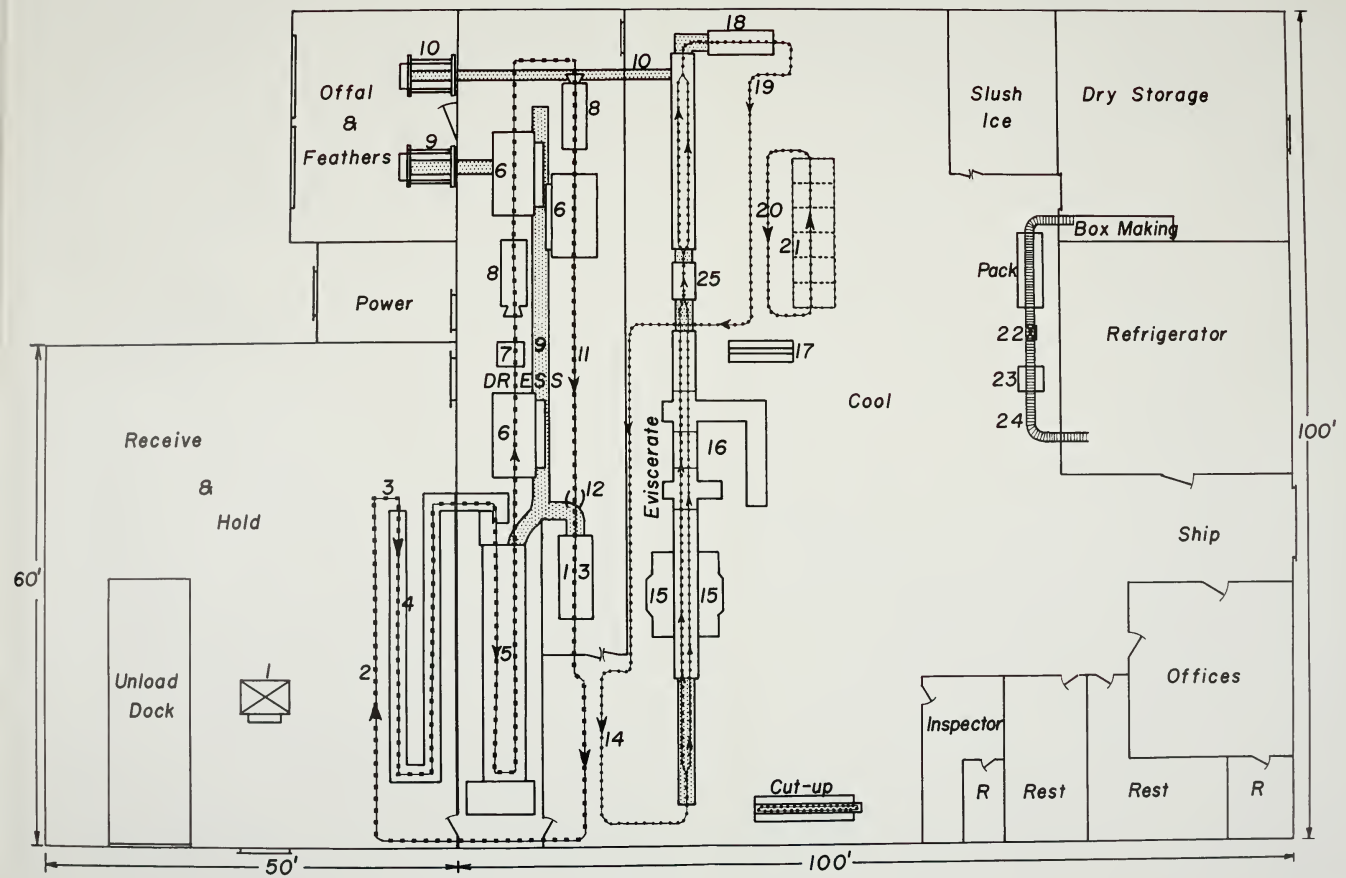

FIGURE III
MODEL PLANT
2400 Broilers per hour

Scale:= 20 feet

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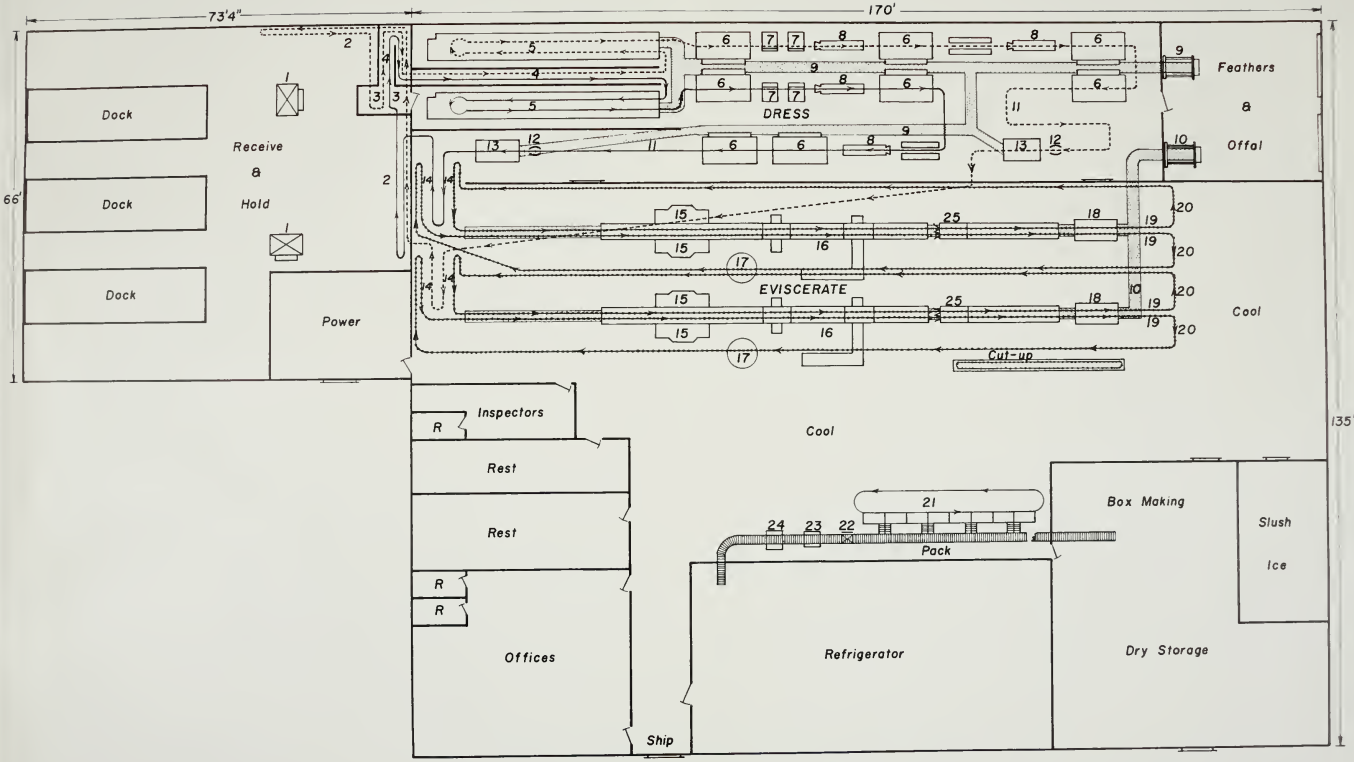

FIGURE IV
MODEL PLANT
7500 Broilers per hour

Scale = 20 feet

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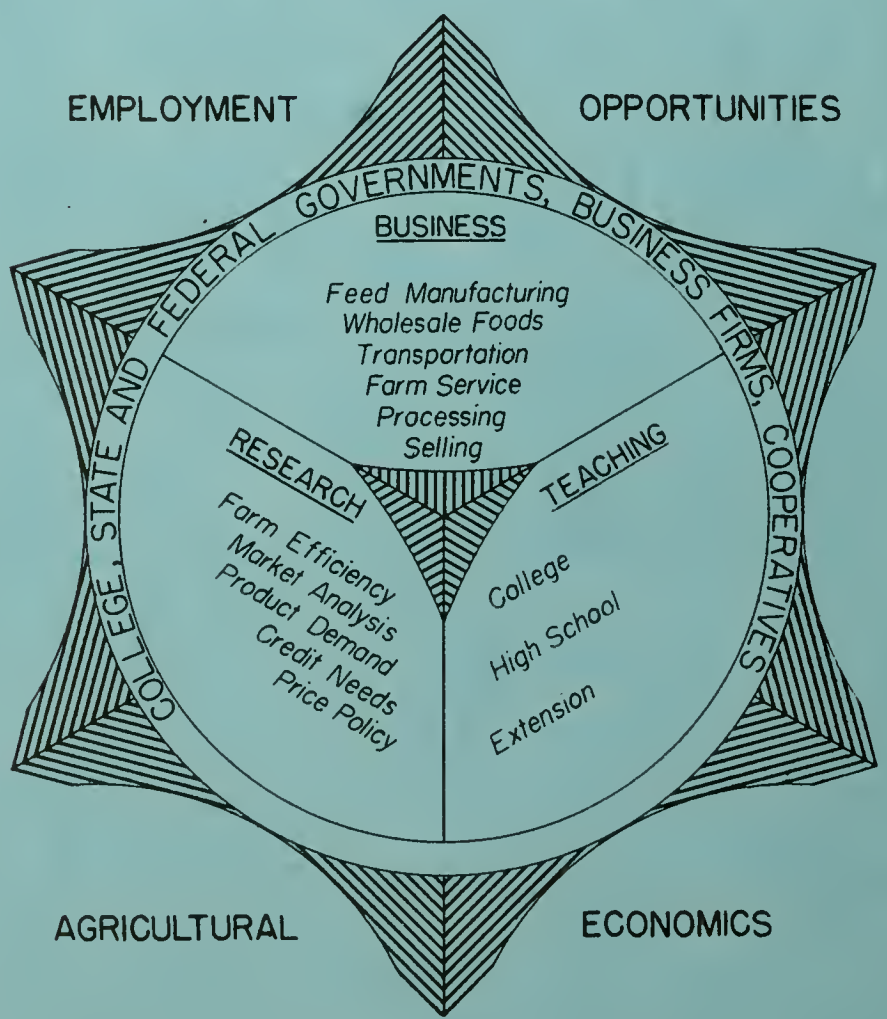

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